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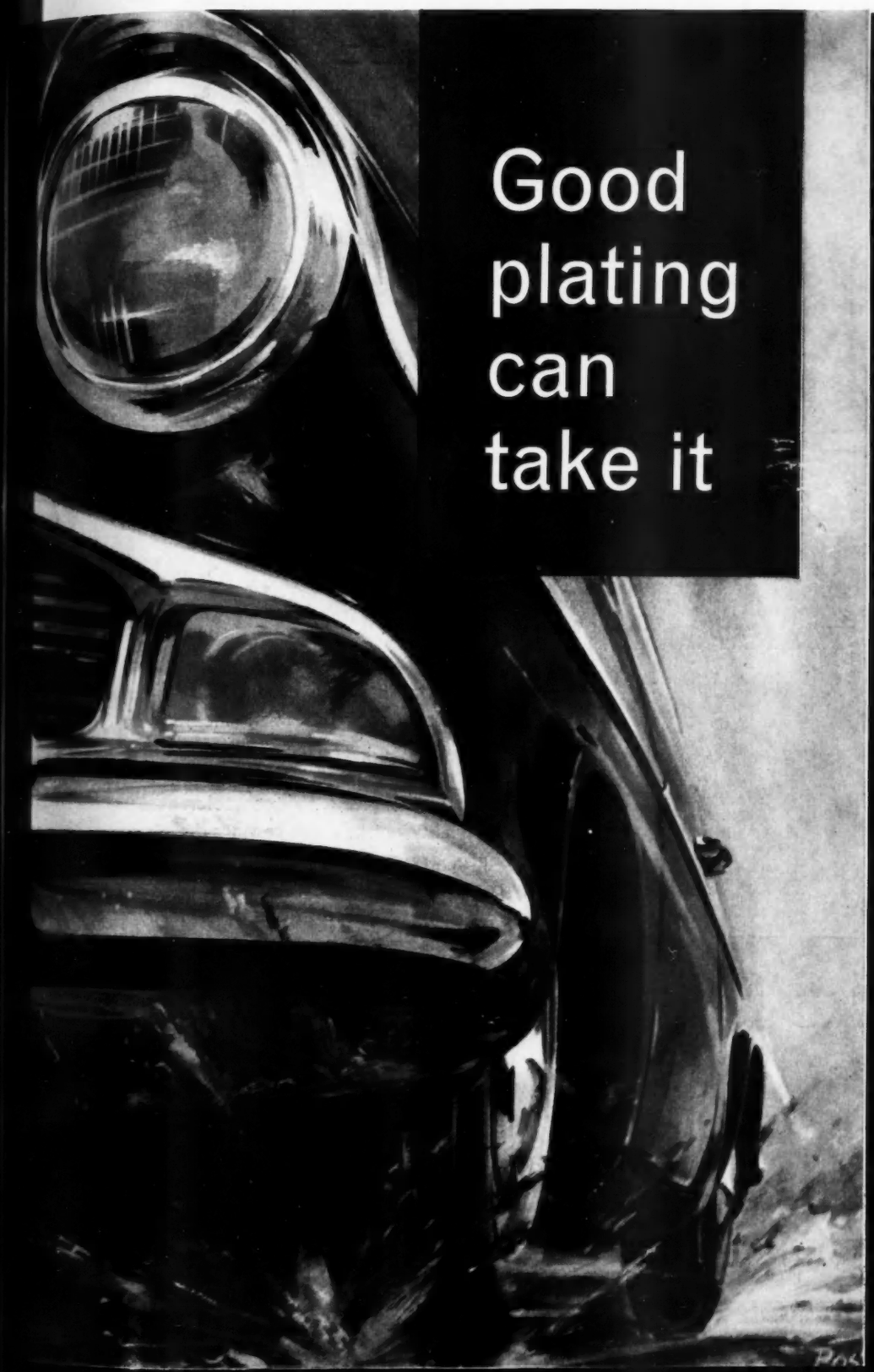

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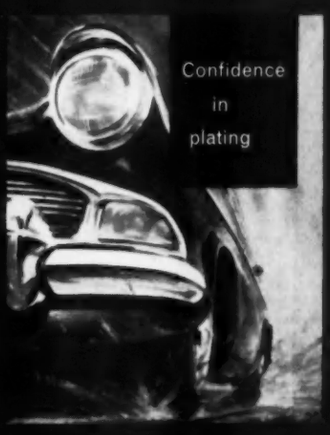

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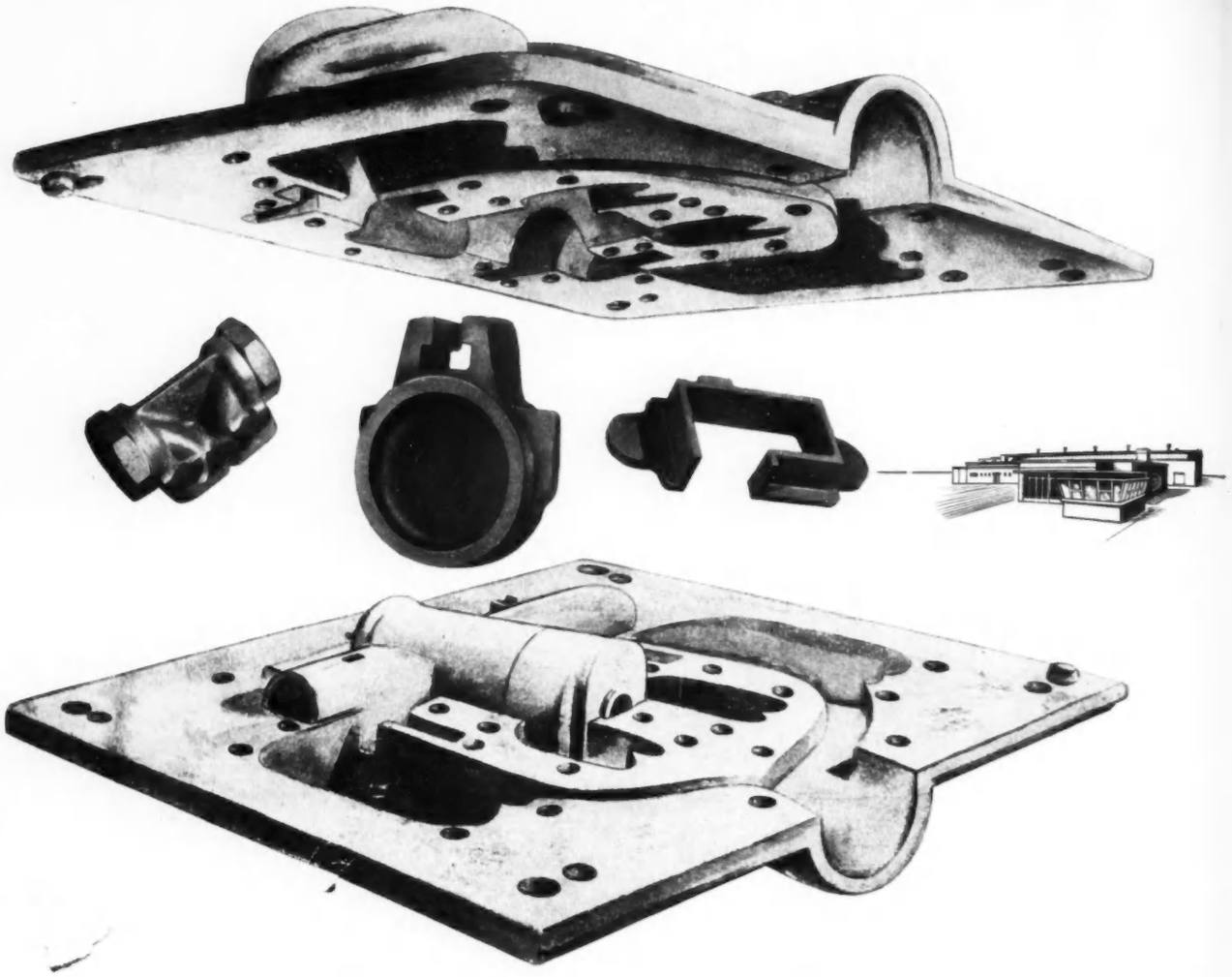

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No. 5516 **OCTOBER 13, 1961** VOL. 212

EDITORIAL CONTENTS

Leading Articles

Planning for Traffic 595
Progress in Fuel Efficiency 595
The Launch of H.M.S. "Kent" 596
Organisation of Conferences 597

Articles

100 Years Ago 597
International Heating, Ventilating and Air Conditioning Exhibition. No. II . . 598
Air-Blast Circuit Breakers for Very High Voltages 600
Electronic Computer Exhibition. No. II 603
African Science Film Congress 605
The Institute of Marine Engineers 606
Hugh Clausen Second International Machine Tool Design and Research Conference 608
P. E. B. Vaile Lubricants for Nuclear Reactors. No. I 610
New Lamps—or Old ?. 611
Training Centre at Cowley 612
Historical Notes on Piling. 614
Preparation of Basic Slag Fertiliser 616
Council of British Manufacturers of Petroleum Equipment 618
Electricity Bulk Supply Tariff. 618
Progress in 50 c/s Traction Practice 618
Diploma in Public Health Engineering 619
Rapidly-Erected Scaffolding 619
Automatic Test Equipment 619
Sensitive Ion Detector for Mass Spectrometer. 619
Mobile Crane of 4 Tons Nominal Capacity 620
Gas Cutting Machine Preserved 620

Continental Affairs

48th Salon de L'Automobile 623
CERN Report, 1960 626
Road Safety Research 627
Julich Nuclear Research Centre 628
W.G.L. Annual Meeting 628
Application of Oxy-Acetylene. 628
Sackingen Power Station 628

American Scene

Computer Programming System for Civil Engineering Problems 629

LETTER Water Grid Use of Existing Canal System. 609

BOOKS JUST PUBLISHED 609

NEWS AND NOTES Industrial News 621
Personal and Business 622
British Patent Specifications 631
Catalogues and Brochures 632
Forthcoming Engagements. 362

INDEX TO ADVERTISERS : PAGE 117 **CLASSIFIED ADVERTISEMENTS : PAGE 111**

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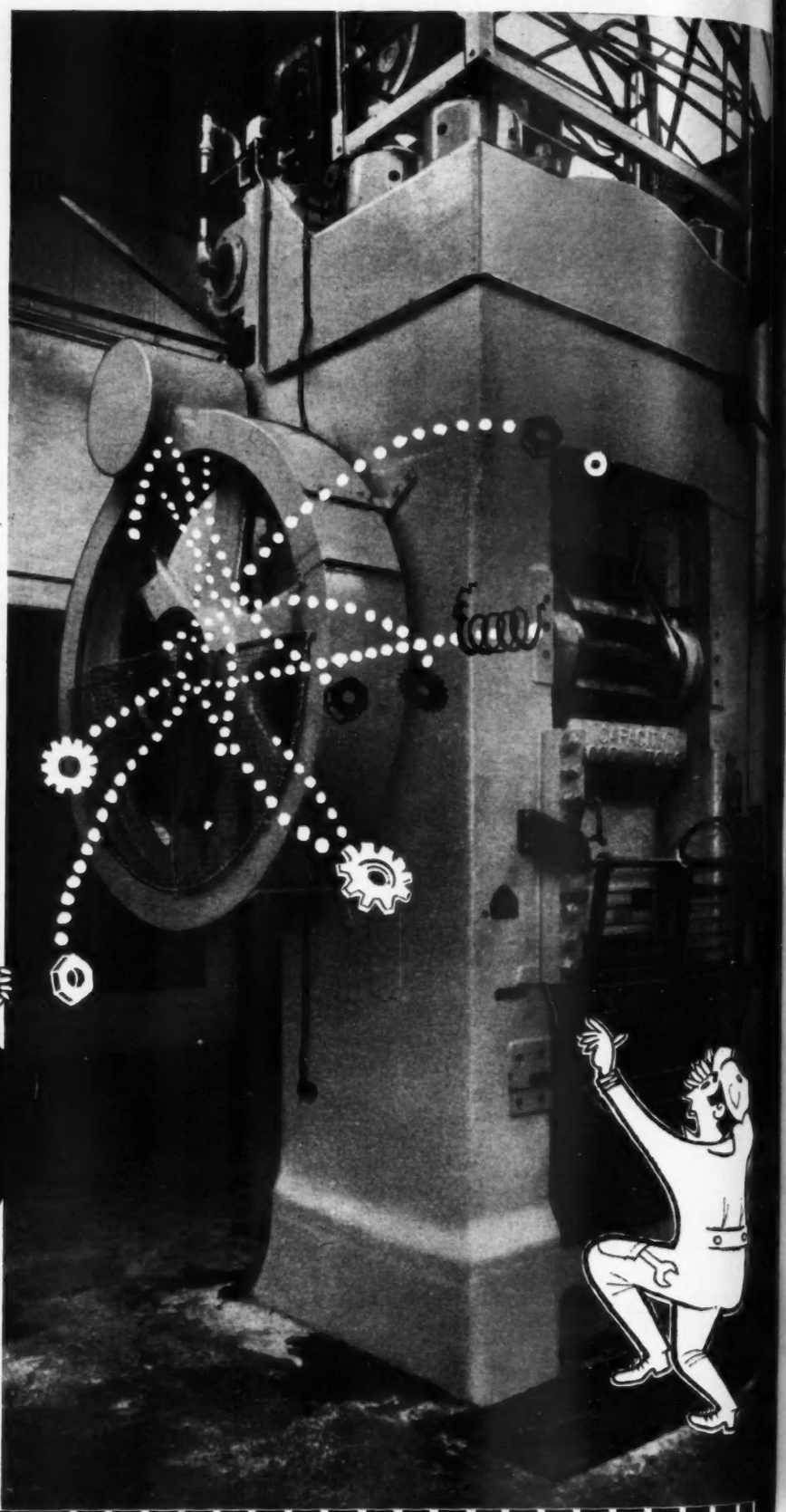

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THE ENGINEER

No. 5516 OCTOBER 13, 1961 Vol. 212

PLANNING FOR TRAFFIC

The Institution of Municipal Engineers is to be congratulated on organising the conference on "Planning for Traffic" which was held on Thursday of last week at the Central Hall, Westminster. The four papers, "London's Traffic Problem" by J. Rawlinson, chief engineer of the London County Council, "Planning for Road Traffic in the Counties" by James Drake and R. A. Kidd, County Surveyor and Bridgemaster of Lancashire and County Surveyor and County Director of Planning of Nottinghamshire respectively, "Planning for Traffic in the Provincial City" by S. Wardley, City Engineer and Surveyor and Town Planning Officer of Bradford and "Planning for Traffic — Road and Rail" by C. W. King, Chief Civil Engineer British Railways Central Staff, are all in print and obtainable from the Institution so that there is little need to do more here than to refer to them and to quote from them as we may think desirable. What was particularly entertaining at the Conference was that Mr. Hay, Parliamentary Secretary to the Ministry of Transport, in opening it defended the Government's road programme while the authors of the papers and several of the speakers in discussions attacked him. In effect he was told that though he could state on behalf of the Government that "We plan to spend £540 millions from central funds on our roads over the next five years — a very large sum of money by any standards" it was not nearly enough. He was also told that though it was not very well to say "that the needs of traffic must have priority and that we should therefore bulldoze our way through private rights and interests . . ." and sound to say that "in this country neither the Government nor local authorities can trample rough shod over the rights of the individual", the delays in getting possession to allow road schemes to go forward were intolerable. Messrs. Drake and Kidd offered diagrams to show that expenditure on roads other than motorways is very far from adequate. Under the present programme it appears the mileage of roads attaining M.O.T. standards of width etc. for the amount of traffic carried will steadily decline for the next twenty years, so small will be the mileage improved and so large the increase in the number of vehicles using them. About a doubling of present expenditure would be necessary to ensure no further deterioration and about a tripling of present expenditure to bring all roads up to M.O.T. standards by 1981. Mr. Rawlinson showed that in a city it "rarely takes less than five years between the time a road improvement scheme is considered desirable and the time the appointed contractor can commence work". We may perhaps hazard the guess that it probably takes the local people at least as long to convince the council that the road improvement is desirable! We do not think that Mr. Hay had anything like a complete answer to offer when he spoke at the end of the morning session. For what is it that really settles the amount that should be spent on the roads of this country? It cannot be wholly a matter of balancing it against the amount spent on other desirable things. For consider the peculiar contrast between the expenditure on the roads and that on electricity supply. It is apparently unthinkable that power available should ever again fall below the peak demand for it, with the consequence that capital expenditure on the provision of power stations and on their maintenance is always adequate to ensure that it does not. But it is apparently regarded as not serious that the capacity of the roads of this country should fall below the peak demand or even the ordinary daily demand. Is it not to be asked in the context of the effects on the economy of this country whether the distinction in treatment may not be unreasonable? As for delays in getting down to the job, anyone who examines the nature of the curve relating the number of vehicles on the road to the passage of years must surely be convinced of the urgent need to cut the cackle and get down to the bulldozers.

PROGRESS IN FUEL EFFICIENCY

The seventh progress survey, covering the year ended March 31, 1961, of the National Industrial Fuel Efficiency Service recalls that although there is now an abundance of fuel, industry has become increasingly appreciative of the benefits conferred by the Service. As a result of these changed circumstances, income policy has been modified, and the decision made that clients, since they derive considerable financial advantage, should be asked to meet the full cost of services given. By making changes on a more commercial basis it was hoped to reduce the amount of financial support from the fuel industries. The report indicates the effect of this new philosophy, for income this year amounted to 70 per cent of the costs compared with 58 per cent in 1960. It is also noted that the technical staff was reduced largely due to the National Coal Board expanding its technical service but nevertheless the smaller staff achieved a 20 per cent increase in bookings and earnings. Reference is made to the practical training sponsored by N.I.F.E.S. and the gratifying increase, from 476 to 647, in the members taking the courses for boiler operators.

Work outside the country is noted and particular mention made of Ireland, Canada and India. During the year under review 11,000 visits were made to factories using appreciable amounts of fuel, and fee-earning work was carried out for 1,441 clients, of whom 585 were new, while the cumulative total covering the years 1954-1961 was 5,669. Regular service agreements increased by 11 per cent to 882. Investigations concerning boiler plants continued to provide the bulk of the work and the report mentions that in seven years 2,871 boilers burning about 5,000,000 tons of fuel a year have been tested for efficiency and that this year's results confirm the Service can reduce fuel consumption by one ton in seven.

This year's report deals mainly with the motor car, whisky distilling, and brick and pottery industries with particular emphasis on drying processes and waste heat recovery, in both of which the Service proved fruitful in achieving substantial savings. A section of the report is concerned with efforts to solve problems of smoke, grit and dust in reducing atmospheric pollution in conformity with the Clean Air Act. Details of training and refresher courses are set out and charts give an overall survey of the various plant items covered by N.I.F.E.S. engineers in the motor car and foundry industries. Examples of the work are included in the report and figures quoted for the annual saving in fuel costs, apart from the benefits of increased production. Flow diagrams illustrate the improvements recommended in whisky distilling, a very conservative industry, in which dispensing with the old fashioned and adoption of the modern has resulted in a reduction in the fuel bill of about 50 per cent, apart from a worthwhile saving in labour costs. Specific examples of improvements in drying processes are recorded in the report for the manufacture of bricks and ceramics, woollen fabrics and chemical plant, and also in waste heat recovery in glass works, steel manufacture and brewing.

The new financial policy of making a commercial charge for the services of engineers is not unreasonable, for the average saving in fuel of about one ton in seven represents a financial gain warranting the payment of a commensurate fee. This relieves the nationalised industries of certain charges and thus indirectly the taxpayer. Greater return from a smaller staff is an excellent achievement but the fact that the loss of staff appears to be largely due to the National Coal Board's policy of expanded service to consumers is a little disturbing because the Coal Board has an "axe to grind" whereas N.I.F.E.S. has not. The number of participants in the training courses for boiler operators is encouraging, for it is through the medium of these courses and those for plant engineers that N.I.F.E.S. will make its contribution to the reduction of atmospheric pollution. The increase in the placing of work on a continued basis means the extension of the Service upon fuel efficiency. It is evident from the savings being effected that the influence of the cheap coal era is still evident and that many firms consider the fuel content of manufacturing costs is not worth investigation. One of the examples quoted in the report clearly shows that even new plant can benefit from advice; for whatever the qualifications of a particular engineer there is always some design item or special operational condition which calls for modification and can be effected by drawing upon the large fund of experience collected by N.I.F.E.S. so that its engineers can help towards establishing optimum conditions. Work in boiler plants is now well established so that it is encouraging to learn that attention is being turned increasingly to process work. Examples given in the report indicate that considerable savings can be made in this field by a careful study of conditions and requirements. These may even call for modifications in part or complete redesign involving the advice to the conservative to scrap the conventional and replace with new equipment embodying the latest theory and practice without affecting adversely product quality. In an increasingly competitive world it is essential to reduce manufacturing costs and one way to achieve this is by investigating fuel consumption. That this can be done with advantage has been amply demonstrated over the years by the work of N.I.F.E.S. which has shown that process costs can also be reduced and production efficiency improved.

THE LAUNCH OF H.M.S. "KENT"

When Her Royal Highness Princess Marina Duchess of Kent launched H.M.S. "Kent" on September 27 at the Belfast shipyard of Harland and Wolff, Ltd., she brought back into service one of the oldest ship names in the Royal Navy. But this new vessel is more than a reminder of ships which have been acquiring Battle Honours during the past three centuries. She emphasises the change in the conduct of sea warfare resulting from the existence of the aeroplane and submarine and still more the help given by British engineers in solving this country's naval problems during a period of uncertainty. H.M.S. "Kent" is, in fact, the third of six ships under construction or on order which represent something of a triumph for British engineering. For a naval power with world-wide commitments whose expenditure on defence has to be scrutinised with the greatest care, it is by no means certain that the advantage for surface ships of the large radius of action at high speed given by nuclear propulsion is sufficient compensation for the very high cost of the type of nuclear power plant required. Given a well organised and efficient afloat support, nuclear propulsion has not yet become an essential requirement. But in these days of nuclear weapons and high speed strike aircraft and underwater vessels it is certainly essential for surface ships to be able to get under-way quickly and to proceed at high speeds for considerable periods of time. And this is exactly what H.M.S. "Kent" and other ships of her class are capable of doing, with propulsion machinery consisting of two sets of geared steam turbines for normal steaming conditions, and gas turbines to provide the additional boost for high speeds when required. The gas turbines of the "Kent" were manufactured by Harland and Wolff Ltd., and that firm also manufactured her steam turbines in conjunction with Associated Electrical Industries, Ltd.

That this class of ship also emphasises the change in the conduct of sea warfare is clearly shown by her armament. Instead of the armament of 6in guns which ships of between 5000 tons and 6000 tons would in past years normally have carried for the defence of sea communications she will have four radar controlled 4·5 in guns in two mountings located forward, one "Sea-slug" anti-aircraft guided weapons system with a twin launcher and two "Seacat" close range anti-aircraft guided weapons systems fitted abaft the after funnel. She will also be equipped with the latest air and surface warning radar. Finally, for anti-submarine work, she will be fitted with the latest underwater detection equipment and a Westland "Wessex" gas-turbine helicopter which will carry dipping asdic and homing torpedoes.

Incidentally, the stabilisers fitted in this class of ship will do much to facilitate the operation of the helicopter in adverse weather conditions. It is interesting to note that the Admiralty is quite satisfied that these so-called "County" class destroyers will be able to fulfil all the operational roles expected of conventional ships of this size. This means, in fact, that in addition to providing anti-aircraft and anti-submarine defence for task forces, their 4·5in guns should be able to deal effectively with an unidentified vessel reported by aircraft, possibly 100 miles away from the carrier. On investigation the vessel may indeed well prove to be a disguised raider armed with 6in guns. But the reliance which the Admiralty places on these powerful destroyers is no doubt also based on geographical considerations. Mr. Kruschev's statement that surface warships are of little value and that he intends to scrap his cruisers may or may not be true. But, in fact, Soviet cruisers would not find it easy to get out on to the ocean trade routes from the Baltic or the Black Sea without being located. Even the Arctic route would confront them with many difficulties. Other special features of the "County" class are their combined operations room and weapon direction room fitted with electronic plotting facilities and their well-designed bridge which will afford the captain a clear all-round view combined with the best possible weather protection.

ORGANISATION OF CONFERENCES

We had the pleasure recently of a run by train to Folkestone and back as the guests of Conference Hotels Ltd. This organisation has come into being to "take over" from those who are called upon to organise conferences of one kind or another. It has joined up with a number of South Coast hotels and is receiving the co-operation of British Railways. It intends to do for the conference organiser much what a travel agent does for the traveller. Tell Conference Hotels Ltd. what kind of conference it is to be, how many will attend, what scale of cost will be appropriate etc. and that organisation will do the rest, including the arrangement of travel and the booking of conference halls and rooms for those attending.

Conference Hotels, of course, intends to make money out of this service; so do the hotels; so also, no doubt, does British Railways. But we think a service is also likely to be rendered to the community by the coming into being of the new organisation. The new organisation should very soon be able not only to give advice to hotels hoping to attract conferences but also, and more importantly, to be able to bring to bear on them pressure to equip themselves properly. In the past even those who have organised large conferences have sometimes had to put up with accommodation that was far from perfect. But pity more those who have had to organise small affairs for as few as 30 to 50 people! We have sad memories of an evening spent in a room trying to listen to a talk and a discussion while next door behind the flimsiest of partitions a dinner for some 200 people was in progress. It was bad enough to have to compete with the clatter of crockery and the hum of conversation; but when the speeches began, assisted by loudspeakers, the small meeting had to break up in disorder! We have sad memories, too, of large crowded meetings in halls in which the lantern screen was fixed barely above floor level so that only those in the front two rows of seats could see the slides projected; of large and crowded halls without loudspeakers; of halls where the process of turning lights on and off was a complicated and time consuming process; of places where speaker and projected slide were so far apart that even with an outsize pointer the twain could never meet; and of blackboards supplied without chalk nor any apparent means of getting any. We have memories, too, of hotels careless about the time of calling sleepers and apparently incapable of serving breakfast within a period of less than an hour. We have known organisers place conference attenders in hotels distant from the conference hall, disconnected from any form of public transport and with porters queerly unable to command a taxi service. Need we mention the despair of hard drinkers condemned to temperance hotels or the fury of pledge-signers accommodated in "pubs"?

Decidedly there seems to be much that Conference Hotels Ltd., should be able to do to raise the whole standard of the organisation of conferences in this country. On the Continent there seems to be a quite marked trend towards the erection in provincial cities of new and rather showy conference buildings containing two or more halls of different sizes and restaurants, the halls being fitted with all needed equipment including often that for simultaneous translation. In Britain there is no such marked tendency. Yet if hotels can be induced to equip themselves adequately for the holding of conferences it may be possible to provide conference facilities just as good as those on the Continent, in pleasanter surroundings and more conveniently situated in relation to bedroom accommodation.

The Engineer—100 Years Ago (OCTOBER 11, 1861)

The Main Drainage of London

"The simple and most disgraceful truth is, that London, though intersected in every part by a web of sewers 2,000 miles in length, is one of the worst drained cities in the world. It is all owing to the Thames, or rather to the disgusting use which is made of that noble river." Thus, on October 11, 1861, did we introduce a note on the progress of the work in hand to improve conditions in the metropolis.

On the north side of the Thames three east-west sewers were in course of construction, one 9 miles long, one "upwards of twelve," while the third was to be on a course which "... has not yet been determined upon." Similar works were in progress on the south side of the river, and in all an area of 101 square miles was to be drained "... involving the construction of more than 50 miles of intercepting sewers, nearly all underground; of upwards of 12 miles of colossal outfall sewers, and of a large number of bridges, pumping-stations, and reservoirs, themselves works of no ordinary kind."

The scheme was inaugurated in 1859 and it was expected that the work would be finished "... in less than two years from the present time." Of the total estimated cost of £3,000,000, about one-third had already been spent, and contracts for the remainder of the work "... are now, or soon will be, in the course of execution." At the time of writing "... a little army of navvies and brick-layers ..." was employed on the north side of the river and on the south the same busy scene was to be encountered at various points. It was estimated that there were "... no fewer than 6,000 men engaged on the works, and if we add to these the persons employed in making bricks, quarrying stones, and otherwise producing materials for the undertaking, in all probability the total number will not fall short of 10,000."

International Heating, Ventilating and Air Conditioning Exhibition

No. II—(*Concluded from page 569, October 6, 1961*)

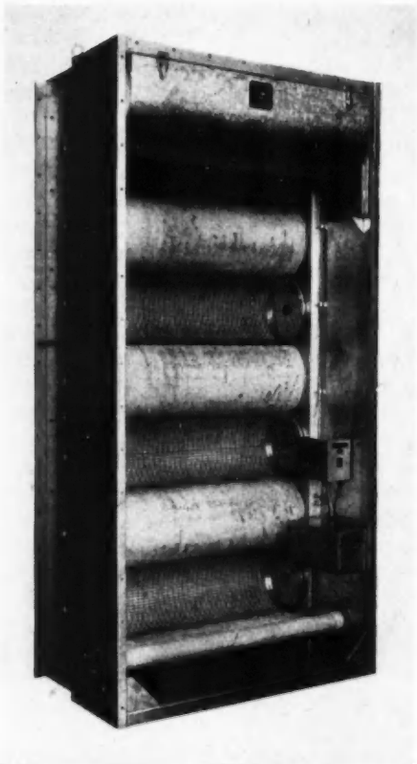
WE conclude our account of the International Heating, Ventilating and Air Conditioning Exhibition, the first part of which appeared in our issue of October 6, with further descriptions of some of the equipment on view. The exhibition, which was held at Olympia, London, was opened on September 26 and closed on October 6.

The Carrier Engineering Company, Ltd., displayed by model and photograph, examples of the company's products including the "Weathermaster" conduit system of multi-unit air-conditioning. This has a central plant which delivers air under pressure to induction units in each room around the perimeter of the building, to provide winter heating and humidification, summer cooling and dehumidification and silent, draughtless ventilation. The "Weathermaster" unit which supplies the primary air to the system, is manufactured in three sizes ranging in capacity from 6500 to 21,000 cubic feet per minute. It consists of a casing containing a water-sprayed cooling coil, eliminators, reheater coil, and water tank with spray pump and motor, screen filter make-up valve and overflow; and a centrifugal fan, mounted on an anti-vibration base, draws air through the unit. Also illustrated were automatic absorption refrigeration machines for use where steam is available, and some thirteen sizes of machine are built which range in capacity from 60 to 705 tons refrigeration and have a normal steam rate of 19·4 lb per hour per ton while the nominal condensing water flow ranges from 190 to 2040 gallons per minute.

In addition to the copper storage calorifier, Royles, Ltd., showed an example of its Type "E" calorifier which is designed for smaller duties and is made in three sizes covering heating services up to 300,000 B.Th.U. per hour or hot water supply up to 300 gallons per hour. The unit is of cast iron and no floor support is required since the calorifier forms part of the piping, furthermore it can be mounted vertically or horizontally or at any angle and the position of the flow and return connections can be changed on site. Also on view were three examples of the redesigned Type "D" non-storage calorifier (illustrated herewith), having a heating surface of indented copper tubes in battery form which is withdrawable. Twelve sizes are available covering outputs up to 16,000,000 B.Th.U. per hour, and the working pressures are 150 lb per square inch on the steam side and 100 lb per square inch on the water side.

Type "D" series 2 calorifier

On the stand of Parkinson Cowan, Ltd. was a new gas radiant air heater, designed to bridge the gap between industrial and domestic heaters, which is known as the Parkinson Schwank "Merlin." It consumes one-eighth of a therm of gas per hour and has an output of 130,000 B.Th.U. per hour, sufficient to heat 2700 cubic feet of air space. Another heater was a mobile windproof two-burner unit having a chassis capable of taking two 24 lb propane cylinders or two 32 lb butane cylinders. The rating is 25,000 B.Th.U. per hour and the consumption per burner is 4·3 cubic feet per hour on butane or 4·9 cubic feet per hour on propane, the pressure at the burner pressure point being 11–13in water gauge. On the stand of an associated company, Bastian and Allen, Ltd., were two examples of the controlled output electrical storage heater, "Con Stor," giving off-peak heating with on-peak control. The resistance elements are embedded in the core plates and the charging period is controlled by timeswitch and a core thermostat. When heating is required the fan is switched on at full speed for rapid preheating. The fan speed is variable and is controlled by a room thermostat so that the required temperature is maintained.



"S" mat automatic air filter

Among the exhibits shown by Ozonair, Ltd., was its "Hi-Jet" velocity induction system designed for use in large multi-room buildings. This room unit is quiet in operation and has a high induction air ratio and thermal efficiency and these together with single or double water coils in parallel and five interchangeable injecting nozzles provide high thermal capacity. The volume of primary air and induced air in circulation is constant and the absence of return air avoids cross contamination. Another exhibit was the "S" mat automatic fabric air filter which we illustrate. In this a number of open mesh drums are arranged in tangential contact and a spool of filtering material is fixed at the top of the casing and fed over the drums which ensures rigid support over the whole operating area. The "S" formation gives maximum effective area and the material is taken up when dirty on a spool at the base. Units are available having a panel width ranging from 3ft to 6ft and heights varying from 4ft to 15ft while the capacities range from 6000 to 63,750 cubic feet per minute.

Floor-mounting Fullway "Mopump"

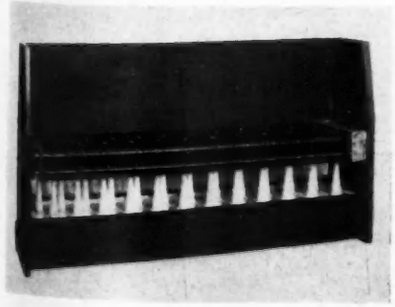
Pumps for heating, air conditioning, and other ancillary services were on view on the stand of Rhodes, Brydon and Youatt, Ltd. Included were floor-mounting Fullway "Mopumps," an example of which we illustrate. These units have a cast iron casing and cover and are fitted with a balanced mechanical seal. Large water passages through the pump offer small resistance and gravity flow continues even when the pump is stopped. The open pattern single inlet impeller is of gunmetal and there are no bearings in the pump which is powered by either a four-pole motor running at 1450 r.p.m. or a six-pole motor at 950 r.p.m. There are six branch sizes available, from 2½in to 8in, and these cover duties from 20 to 80 gallons per minute. The main exhibit was a "Mopump" automatic hydro-pneumatic pressure booster set which operated on the stand to a height of 18ft to exemplify even pressure water supply to tall

buildings. Also shown was an example of the company's "SC" range of pumps designed for boiler feed and similar duties.

Brightside Heating and Engineering Company, Ltd., exhibited "Brightrad" radiant heating equipment in its various forms, also single duct, dual duct, induction and industrial high velocity air systems. The single duct system suits constant or slowly changing load conditions, high velocity air being brought to the required condition in the control plant before distribution. Widely varying load conditions in separate areas are met by the dual duct system which is flexible in operation and able to maintain accurate temperature conditions and comfortable humidity levels while providing constant air delivery. In this system high velocity air, at different temperature levels, is conveyed in twin ducts from the central plant to each distribution box the air being mixed as required and supplied at low pressure to various rooms. In the industrial system a central air conditioning plant delivers conditioned air through a high velocity ducting system to high pressure silencing distribution terminal outlets.

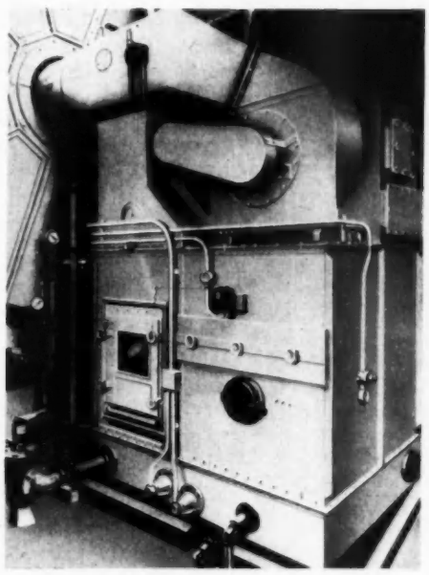
A full range of its steam equipment was displayed by Midland Industries, Ltd., including thermostatic and float operated steam traps and the latest addition to this range the "Mil" Thermatic trap. This works on a change of phase principle in that the valve is held on its seat by the conversion of the kinetic energy of flashing condensate into pressure energy, and when this is destroyed the valve will open to discharge the condensate. Six components form a complete trap streamer unit, there being only one moving part, the valve. The internal trim is of stainless steel while the body materials may be manganese bronze forgings, stainless steel castings or cast carbon steel. There is ample straining capacity and a sludge reservoir and no gaskets are used in the assembly, all mating surfaces being metal to metal. Two sizes, $\frac{1}{2}$in and $\frac{3}{4}$in are manufactured and are suitable for a pressure across the trap ranging from 5 to 250 lb per square inch with a manganese bronze body and up to 490 lb per square inch with stainless steel or cast carbon steel bodies. The maximum continuous discharge capacities cover from 180 to 2300 lb per hour.

On stand of Sulzer Brothers (London), Ltd., were shown models and photographs exemplifying the wide heating and ventilating interests of the company and including the high velocity air-conditioning equipment with emphasis on induction "Klima" convectors and dual duct mixing units, "Uniturbo" refrigeration equipment, weaving mill air distribution, Burgess-Sulzer heated acoustic ceilings, "Hi-Strip" radiant heating, electrode boilers and "Dor-Less-Dor" air curtains. The "Klima" convector, seen in our illustration, is a component which can be used for air conditioning throughout the year, fresh air being supplied from a central air conditioning plant at high velocity to individual convectors. In the dual-duct equipment one duct takes warm air and the other cold air, both of which have been treated in a central plant, and mixing units blend the warm and cooled high velocity air streams under the control of a room thermostat. The heated acoustic ceiling consists of Burgess acoustic tiles, to give selective sound control, and Sulzer radiant heating to give controlled warmth. Heating is provided by coils through which water at a mean temperature of between 170 to 185 deg. Fah. is circulated and these coils heat the tiles through radiation and convection.



"Klima" convector, with front casing removed, showing nozzles and heating/cooling battery

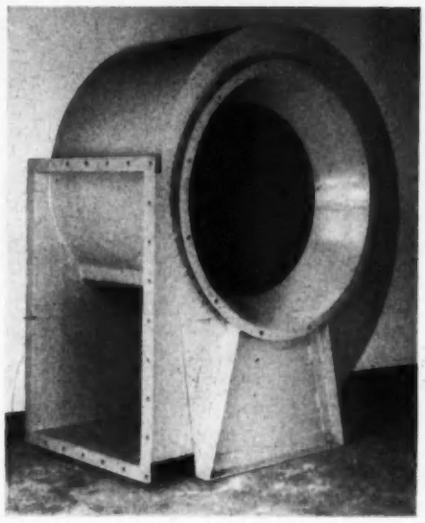
Felcoil Burners, Ltd., displayed examples of its range of industrial burners, including the Felcoil "Minimat" unit in which fuel savings of from 8 to 12 per cent are effected by the automatically closing air inlets. These close when the burner motor stops, thus preventing cold air being unnecessarily drawn into the boiler flues. In this fully automatic heavy oil pressure jet burner, instant ignition of oil on start is ensured by the built-in induction heater which is effective up to the snap action nozzle cut off valve, and eliminates any dead leg of oil. The electrode and nozzle assembly is easily accessible and for servicing the slackening of a single wing nut allows the burner to be pulled back along a slot in the mounting table and then turned round to expose the combustion head. The low flame start in the high/low and modulated flame control installations results in longer life for the boiler and brickwork lining. There are four models which cover a capacity range of from 160,000 to 6,000,000 B.Th.U. per hour.



Vertical air conditioning unit of 2500 cubic feet per minute capacity

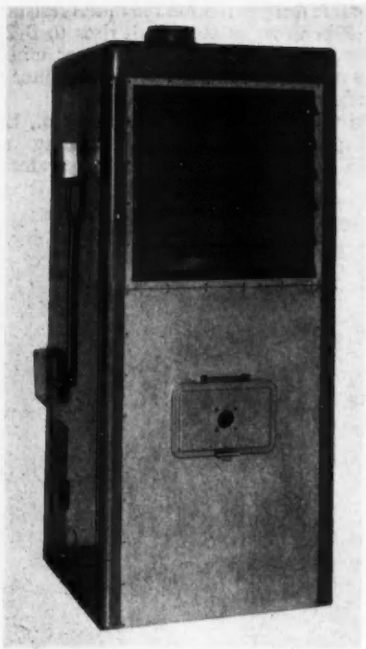
Oil-wetted and dry pattern air filters for a wide variety of applications were on the stand of Visco, Ltd., including the new automatically operated dry pattern "MV" air filter. This consists of a frame and a removable cell consisting of two sections which fit together to hold the filter pad between them. The throw-away filter pads are of synthetic fibrous material. The assembled cell rests on side cheeks in the frame and is held against a felt seating by spring loaded clamps. Each unit will deal with up to 1000 cubic feet per minute and at 600 cubic feet per minute the initial resistance is 0·09in water gauge which rises to 0·22in water gauge at 1000 cubic feet per minute. Tests using Aloxite 50 show that the filter has an efficiency of over 98 per cent.

On the stand of Davidson and Co., Ltd., was a "Sirocco" air-conditioning unit which we illustrate and which operates on the evaporative cooling principle. The unit consists of a galvanised base tank fitted with connections for chilled water, steam, or immersion heater elements. On the tank is mounted a galvanised sheet steel air chamber having a mid-feather centre division to form a double pass unit. The first pass is piped for banks of opposed water atomising nozzles and in the second pass is a further bank of nozzles and a removable double pad of nylon mesh for use as the free moisture eliminator. A hinged door gives access to the nozzles while portholes allow for inspection during operation. On the air chamber is an air mixing box fitted with fresh and return air openings and for final control of dry bulb temperature an electric or steam heater fitted on the suction side of the fan. When operating on evaporative cooling the unit is capable of producing a 95 per cent wet-bulb depression, but dehumidification and lower dry-bulb temperatures can be attained by using chilled water. The unit illustrated has a capacity of 2500 cubic feet of air per minute, a spray capacity of 42 gallons of water per minute and 6 to 13 tons refrigeration. Three models are available, the air volume ranging from 1000 to 4000 cubic feet per minute, the spray capacity from 21 to 58 gallons per minute and a maximum tons refrigeration rating of 19. Also exhibited was a "Sirocco" "U" pattern centrifugal fan designed for general industrial application and produced in twelve sizes. The fan, which can be seen in our illustration, is of wide casing design having high volumetric capacity; it is belt driven and there is a choice of three runner designs, namely the UFB 70, the U.B.C.B. and the U.B.A.B.



"U" pattern centrifugal fan

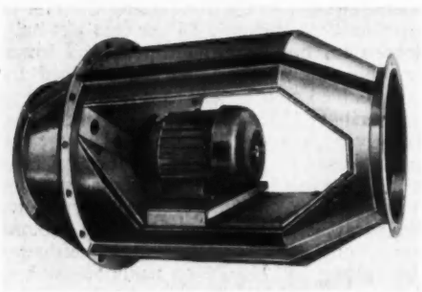
James Gordon and Co., Ltd., displayed complete instrumentation for boiler and power plant including pneumatic automatic control and equipment for steam pressure reduction. Electrical automatic control for small boilers has been developed based on experience with larger units and the equipment was on view. Another of the company's products on view was the "Konitest" meter which continuously measures the amount



Industrial heater with output of 100,000 B.Th.U. per hour

of dust in industrial atmospheres and flue gases.

A comprehensive set of exhibits on the stand of Hall-Thermotank, Ltd., was representative of the range of the company's products and of interest was the straight-through silencer mounted in the wall of a soundproof cabin and intended for use in air conditioning and ventilating systems. Other silencers shown included the "Alpha" and a high-frequency and cross-talk attenuator. The cabin itself was air conditioned by a wall mounted heat pump, which has a cooling capacity of 18,000 B.Th.U. and a heating capacity of 17,000 B.Th.U., which is a Westinghouse product as are the S.U. air conditioning units having a capacity range of 33,000 to 450,000 B.Th.U. per hour. A working model of a cooling tower was on view, the fill consisting of a lightweight



"Ax-Cent" compound flow bifurcated fan

plastics impregnated cellulose material and occupying only one-fifth of the space needed for wooden slats. The towers are available in standard single-cell units of up to 125,000 gallons per hour capacity and in multi-cell units for larger capacities. Also shown were "Vita-Aire" air purifiers which are based on the photo-electric principle, operating in an ultra-violet field, and produce a flow of negatively ionised air. The output can be varied and the effect of the negative ions is to oxidise and destroy odours. There is a range of twelve negative air generators available for spaces between 4000 and 15,000 cubic feet, while for industrial use there are eight generators for spaces up to 200,000 cubic feet.

A recent addition to its range of kerosene heaters was exhibited by the Valor Company, Ltd., and this is an industrial warm air heater claimed to have a heating efficiency of 85 per cent. This free standing, self-contained unit (seen in our illustration), has an output of 100,000 B.Th.U. per hour and consuming a minimum of 1½ pints and a maximum of 6 pints of kerosene per hour. It is automatically operated and thermostatically controlled and incorporates a fuel control valve, a fuel shut off valve, an air thermostat, and a separate thermostat to prevent overloading. An electric fan circulates the air and the heater output is 80,000 cubic feet of air per hour at a temperature of 90 deg. Fah. with an ambient temperature of 30 deg. Fah.

Keith Blackman, Ltd., had on display a cross section from the "Tornado" fan engineering equipment range including the "Ax-Cent" compound flow bifurcated fan which we illustrate, which combines advantages of both the basic axial and centrifugal designs. The bifurcated casing provides a built-in motor compartment which protects the motor from the gases passing through the duct and is a contributory factor in enabling gases up to 650 deg. Fah. to be handled. The casing incorporates a venturi inlet to a shouded compound flow impeller and the fan provides about twice the pressure development of a single stage axial fan running at the same speed, its volumetric and pressure output being comparable with two-stage axial fans. There are fifteen sizes covering diameters from 9in to 30in, a volume range from 100 to 14,000 cubic feet per minute and pressures up to 14in water gauge static. Another exhibit was a "Tornado-Fischer" automatic self-cleaning filter, representative of a range of dust and fume control equipment, and capable of handling nearly all sizes of dust particles.

Air-Blast Circuit Breakers for Very High Voltages

A range of air-blast circuit breakers suitable for voltages from 132kV up to 650kV, with current ratings of 2000A and 4000A and short circuit ratings of 50 to 60kA, is being developed by The English Electric Company, Ltd. As the interrupter contacts are under pressure at all times, opening is very rapid and the make switch is dispensed with. Assemblies of unit interrupters connected in series can be made up to suit required ratings over a wide range.

INTERESTING developments in circuit breaker design have been announced by The English Electric Company, Ltd. to meet the need for high-performance switchgear to suit the very high voltages and capacities envisaged for the power transmission systems of the present and future. In 1957 in anticipation of these requirements the company drew up a performance specification for a range of air-blast circuit breakers suitable for voltages from 132kV to 650kV (with some further development potential) current ratings of 2000A and 4000A, short circuit ratings up to 50 or 60kA, and very short total break times.

Against the background of experience

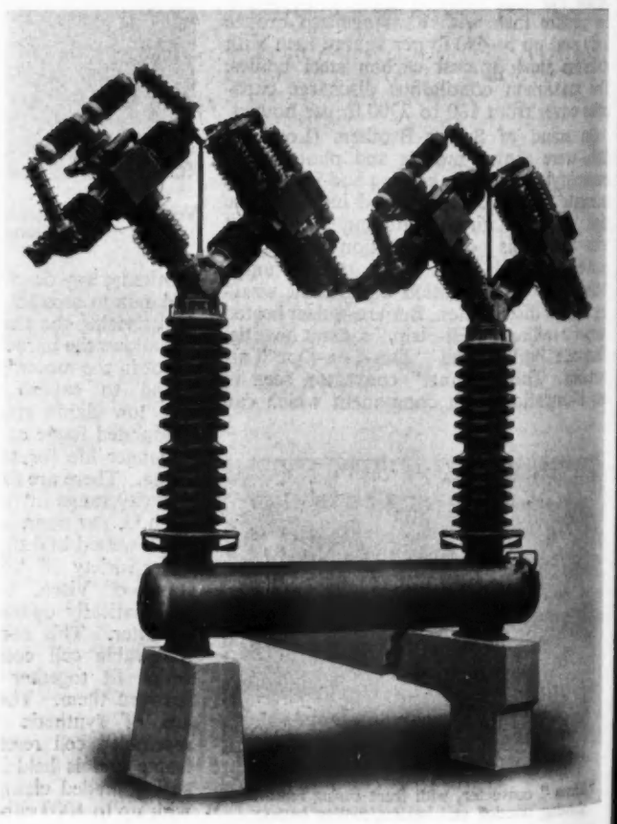
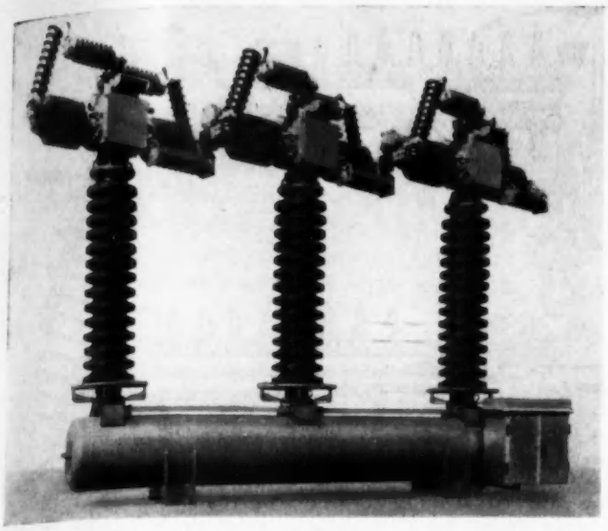


Fig 1.—An eight-interrupter circuit breaker in "Y" formation suitable for 400kV, 25,000MVA



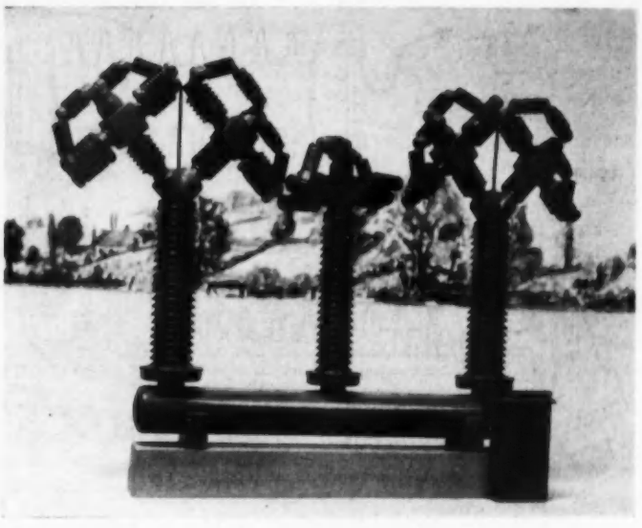


Fig. 2—(Left) A six-interrupter circuit breaker in "T" formation suitable for 275/330kV, 15,000MVA. Fig. 3—(Right) Model of a ten-interrupter circuit breaker in "YT" formation suitable for 400kV, 35,000 MVA or 500kV, 30,000MVA

gained on the company's existing air-blast gear the development of the new "frame-r" circuit-breakers, as they are called, has continued since 1957 with the following main objectives in view.

The circuit breaker should use air-blast interruption and the required ratings should be obtained by assembling multiples of a unit interrupter connected in series horizontally to extend the range to suit the specified voltage. By manufacturing the circuit breaker on the unit basis, each unit being fully works tested, it is not necessary to assemble the complete circuit breaker in the works. An important departure from present British practice is that the contacts should be subjected to full air pressure in both open and closed positions. To do this the blast valve must be downstream of the interrupters instead of being mounted at the foot of the insulator column on the air receiver. The object of this arrangement is to maintain full air pressure at the contacts, avoiding the pressure drop and the time delay involved in pressurising the support insulators when the blast valves are mounted on the receiver. The gain is expressed in the maker's claim of a guaranteed operating time of 2½ cycles, with an arcing time of ½ cycle, and of good performance, particularly on line charging duty. Another advantage of ensuring that the contacts are pressurised in the open position is that the make switch (which presents difficulties at the higher ratings) is dispensed with: thus the arc length on make is reduced from 6in to ½in.

In the "frame-r" circuit breakers designed on these lines the interrupters can be arranged either in Y-formation (with four interrupters per support column) or in T-formation (with two interrupters per support column) or in combinations of both. A circuit breaker with eight interrupters in Y-formation, suitable for 400kV, 25,000MVA is shown in Fig. 1. A circuit breaker with six interrupters in T formation, suitable for 275/330kV, 15,000MVA, is shown in Fig. 2. A model of a ten-interrupter circuit breaker in YT-formation, suitable for 400kV, 35,000 kVA or 500kV, 30,000MVA is shown in Fig. 3.

"Frame-r" circuit breakers will be supplied to meet the first order for 400kV switchgear to be placed by the C.E.G.B., as announced earlier this year. This order covers thirteen 35,000MVA air-blast circuit breakers, eight of which will be rated at 4000A and five at 2000A, together with the power-operated isolators and other apparatus to form a complete duplicate busbar switching station. The equipment will be installed at the West Burton, Notts, power station.

"Frame-r" Circuit Breakers

From Figs. 1 to 3 it can be deduced that many other arrangements are feasible and that for breakers with two or four interrupters per phase all three poles can be accommodated on one air receiver.

Details of the construction of the support columns and interrupters are shown in Fig. 4. The high pressure air (300 lb per square inch) is contained inside the support columns and interrupter porcelains within epoxy resin bonded glass tubes *F*. These tubes are pretensioned to hold the outer porcelain weather sheds in compression. The outer space between the tubes and porcelain is permanently air-conditioned at a positive pressure of 2 lb per square inch above atmospheric.

Operating Mechanism. — The operating mechanism is a small pneumatically-operated spring-trip mechanism of the sort that is well established in oil circuit breaker practice. It is located in a cabinet attached to the main air receiver of one phase and operates control levers (situated in a box on the centre casting of each pair of interrupters) through epoxy glass fibre rods located in the air-conditioned space between the porcelains and main epoxy resin bonded glass tubes. These rods are spring loaded so that there is no lost motion due to slack.

To initiate a trip operation the shunt trip coil is energised, thereby releasing the latch, and through the epoxy glass rods, the subsequent motion causes the master levers in the interrupter control boxes to depress the pilot trip valves which in turn feed the blast valves. To close the breaker the mechanism restores the rods to the latched position thus causing the master levers referred to above to depress the closing valves in the interrupter control boxes.

Interrupters.—The interrupters are built in pairs with one blast valve and control mechanism per pair of interrupters. Each consists of a cylindrical fixed main contact, *A*, which houses a spring-loaded arcing contact *B*, and a moving throat *C* which is located in a second cylinder *D* attached to the centre casting.

Opening of the blast valve drains the air from the back of the operating pistons *E* and the back of the moving throat and causes the latter to move inwards towards the centre of each interrupter pair. With this movement the main current-carrying contacts part, leaving the circuit made through the arcing contacts. The spring-loaded arcing contact is arrested at about half travel distance of the moving throat thus providing a high-speed break. Then the arc is drawn, transferred to the arcing tips and extinquished by the flow of air through the nozzle.

Levers attached to the moving shaft drive an over-toggle spring loading mechanism which holds the contact either closed or open and prevents contact movement in the event of an air leak. The same movement, through a lever, resets the master operating lever to the neutral position ready for closing, which allows the pilot valve and consequently the blast valve to close.

The whole of the interrupter space is then repressurised to full pressure so that the breaker in the open position will withstand full system voltage.

When the closing valve is operated, it drains the space in front of the operating pistons to atmosphere and the differential pressure causes the moving throats to close. Making is effected on the arcing contacts under full pressure with negligible pre-arcing and the spring loaded arcing contact is then driven home, allowing the main current carrying contacts to make.

The levers return the over-toggle spring device to its original position and reset the master lever in the neutral position ready for tripping, thus allowing the closing valve to close.

High speed Auto Reclose.—Immediately after each operation the control mechanism and contacts are ready for the next operation. It is a quick-reset mechanism and thus only the addition of an auto reclose timing relay is necessary. Dead times down to ten cycles or even less can be obtained and by means of the relay any higher dead times can be used.

Performance on line dropping is stated to be very good because of the high pressure and fast break and the breaker is restrike-free.

Resistance Switching.—The breaker can be equipped with two types of resistor—light duty and heavy duty.

Heavy duty resistors are required when the breaker must interrupt short line faults where the short-circuit duty per interrupter

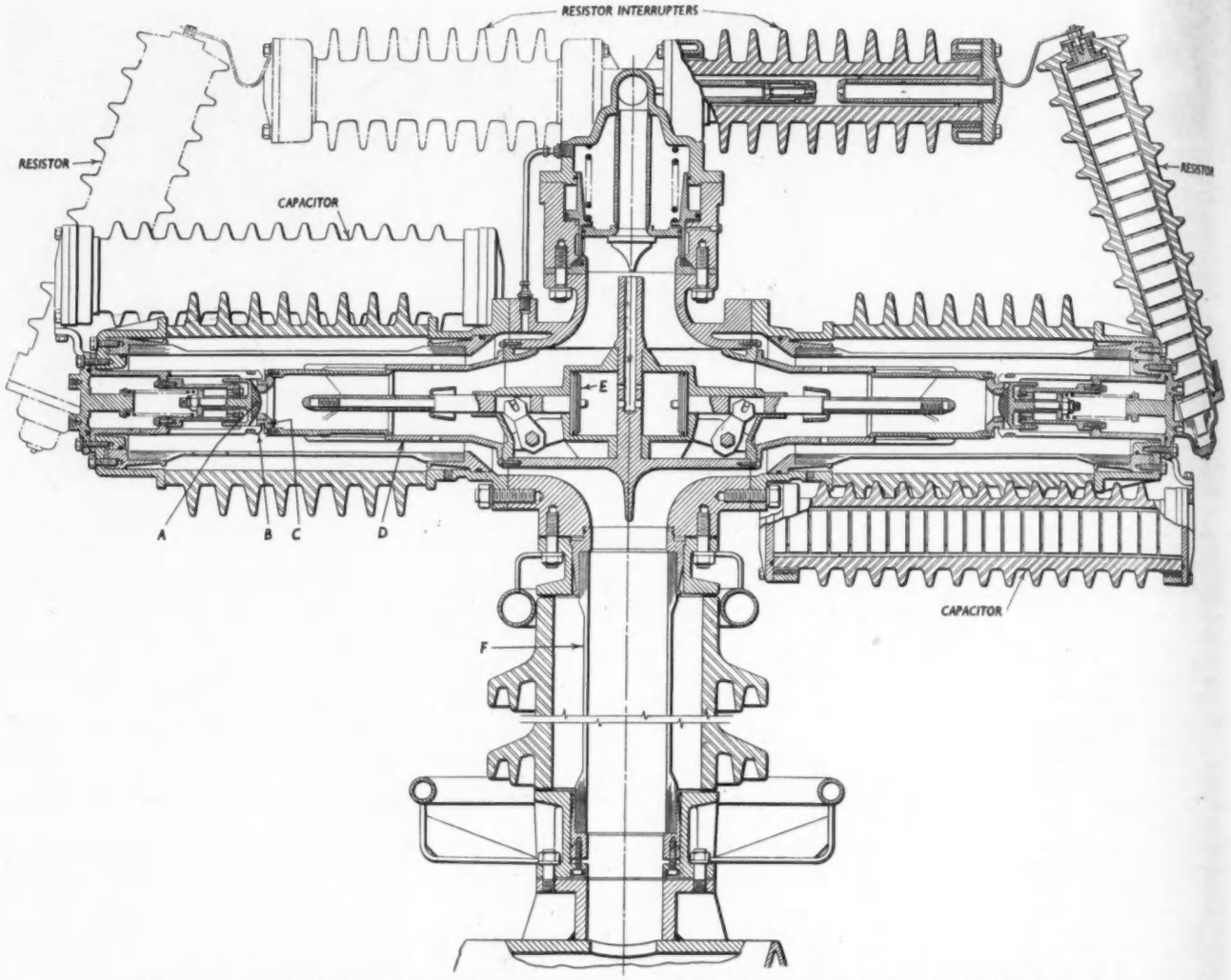


Fig. 4—Arrangement of interrupters mounted in "T" formation on insulating support column of a "frame-r" circuit breaker

is particularly high. But the maker affirms that it is only for the more onerous short circuit levels that these heavy duty resistors are required and then it is not necessary to apply full critical damping of the line side transient, but only enough to bring the rate of rise of restriking voltage within the capability of the interrupters. Light duty resistors can be used in all other cases, their function being to ensure voltage division between interrupters when the breaker is breaking current and to damp out over-voltages when the breaker is switching low inductive currents.

Both sizes of resistor require resistor interrupters and these are automatically switched, on operation of the last valve. The two sizes of resistor and their associated resistor interrupters are interchangeable and it may well be both economical and the best technical arrangement to fit only those breakers which can switch transmission lines with the heavy duty resistors, all other breakers, e.g., transformer breakers, having the light duty higher ohmic value resistors.

Capacitors.—Capacitors are fitted across the interrupters to ensure even voltage distribution in the open position. They also help the resistors in this duty when the breaker is opening the circuit.

Test Plant

Present methods of proving extra-high-voltage multi-gap circuit breakers are based on unit testing of at least one interrupter at 100 per cent of its share of voltage at full short circuit current. The output of the plant can therefore be decisive in dictating the number of interrupters to be employed in a large breaker at extra high-voltage.

To prove breaker ratings up to 50,000 MVA at 550kV and above satisfactorily, and at the same time to keep the number of interrupters to the required minimum, it has been necessary to increase the capacity of the plant at the Nelson high-power laboratory.

The existing plant consists of two 3000 r.p.m. alternators with associated transformers and ancillary equipment. To increase this capacity two new alternators are being installed, together with associated transformer banks and full ancillary equipment, with a capacity to test at voltages up to 600kV. An artificial line suitable for short line testing is being built in the laboratory test area.

A single building adjoining the existing hall houses both new alternators and ancillaries, transformer banks being contained in outside areas at either end of the building. Conducting paths have been kept short by roof mounted bus runs, linking both outputs to the overhead lines and ingoing feeders to the test areas.

There are several innovations in the plant design. They include the provision of servo control for the synchronisation of four machines and the installation, throughout, of pressure immersed make-switches, which give negligible pre-arcing and close control of the point on the wave at which voltage is applied. Each switch has a making capacity of 300kA peak. Where possible up-to-date insulating methods and materials have been employed, an example being the encapsulation of reactor coils in synthetic resins. Plant protection has been increased by the use of air-blast back-up breakers (with three breaks, including resistance switching), giving improved control and safety.

The provision of extra plant has more than doubled the output of the existing equipment, which was itself doubled in 1947. If the present trend in the increase of circuit breaker ratings is maintained, then a form of synthetic testing, acceptable to users, may well be the only economic means available for proving circuit breaker performance. Synthetic testing is envisaged for outputs above 35,000MVA.

Semiconductor Device Materials.—Sample quantities of "Nilo K" strip clad on each side with ·5 per cent gold-antimony are now offered to manufacturers of semiconductor devices by Johnson, Matthey and Co., Ltd., 78-83, Hatton Garden, London, E.C.1. It is hoped that production quantities will be available early next year. The strip is available in widths between $\frac{1}{16}$in (2·4mm) and 2in (50·8mm), in thicknesses down to 0·005in (0·13mm). The thickness of cladding that can be supplied on each face is either 11·5 or 18·75 per cent of the total thickness.

Motor Vehicle Statistics.—The September, 1961, *Monthly Statistical Review* of the Society of Motor Manufacturers and Traders Ltd., includes a table of the output of vehicles in the main producing countries during the first six months of 1961. The United Kingdom was the largest producer of buses with 5266 vehicles, the second largest producer of goods vehicles with 243 884 (U.S.A. 572 857) and the fourth largest producer of cars, with 501,669 vehicles (U.S.A. 2,756,547, West Germany 1,005,407, France 574,552).

Electronic Computer Exhibition

No. II—(*Concluded from page 566, October 6, 1961*)

The following article concludes our review of selected exhibits at the Electronic Computer Exhibition at Olympia, which closed yesterday, October 12. At the opening of the Electronic Data Symposium held at Olympia from October 4 to 6, Sir Edward Boyle, Financial Secretary to the Treasury, said that in 1960 direct exports of electronic computers amounted in value to well over £2,000,000.

Creed and Co., Ltd.

Electromechanical data processing by a system incorporating many elements of the "Doris" equipment (direct order recording and invoicing system) developed for Shell-Mex and B.P., Ltd., was shown by Creed and Co., Ltd., Telegraph House, Croydon, Surrey. The apparatus records sales orders via a keyboard or push-button input unit, and retrieves stored data from a punched tape memory, performing price calculations if required and selectively printing a variety of documents needed for manufacture, delivery and invoicing at multiple local or remote locations.

Peripheral equipment included the model 1000 high-speed output printer, now shown for the first time as a commercially available product. Instead of having a separate solid type for each letter, the model 1000 employs a printing head built up of twenty-five rectangular pins, arranged in a 5 by 5 grid, approximately 0·1in high and 0·08in wide. Characters are formed on the mosaic principle by pressing the required pins against a typewriter ink ribbon so that the outline of a letter is built up by a pattern of rectangular dots. The printing pins are operated hydraulically by 250 lb per square inch impulses supplied to the printing head through the twenty-five nylon tubes seen in the illustration.

Input signals direct from a computer, or from magnetic or punched paper tapes, energise electromagnets which actuate valves admitting oil to the tubes communicating with the appropriate pins in the traversing printing head for forming each character. Speed of operation is 100 characters per second. The printer can be supplied without its own electronics, the character repertoire then depending on the external circuit ; or with built-in six-bit circuitry giving a fifty-eight character repertoire (which can be varied by means of a plug-in diode matrix board).

Another new item of peripheral equipment was the " Creedomat," comprising an I.B.M. electric typewriter with interconnected Creed tape punch and reader units, complete with transistorised circuitry and push-button controls. The equipment provides for the code-punching of five-, six- or seven-track paper tape as a by-product of typing original documents. It also automatically interprets five-, six-, seven- or 8-track punched paper tape and edge-punched cards into typed copy at a speed of 100 words per minute.

Decca Radar, Ltd.

A new tape unit, Type 4000, for use with any digital computer, was shown by Decca Radar, Ltd., Albert Embankment, London, S.E.1. In this equipment (Fig. 8) the pneumatic system for clutching or declutching the tape at the surfaces of the continuously-rotating drive capstans, and its associated control circuits, has been improved so that start/stop times of 2 ms are achieved compared with 10 ms in earlier versions. Tape speeds are between 30in and 150in per second. The capstans are driven at constant speed by a hysteresis motor. Each tape spool is driven by an induction motor under transductor control which maintains a preset quantity of tape in the two reservoir bins, so that accelerating forces, which in this machine are as high as 300g, are not transmitted to the spools. Signals for the transductor control windings are derived photoelectrically, selenium-coated plates being fitted at the back of each bin so as to be illuminated by fluorescent tubes when the light paths are not obstructed by the convolutions of tape. The tubes provide a distributed source covering the 5in width of the bins, and are cool-burning, so that dissipation of heat is not a problem. Two versions of the unit with similar electrical and mechanical parameters are available for handling 1in and ½in magnetic tape. The standard cabinet as illustrated contains one tape transport, electronic circuits, manual control panel with logical interlocks, head amplifier circuits, and power and vacuum supplies, the latter being the means by which the tape is caused to grip the surface of the drive capstans

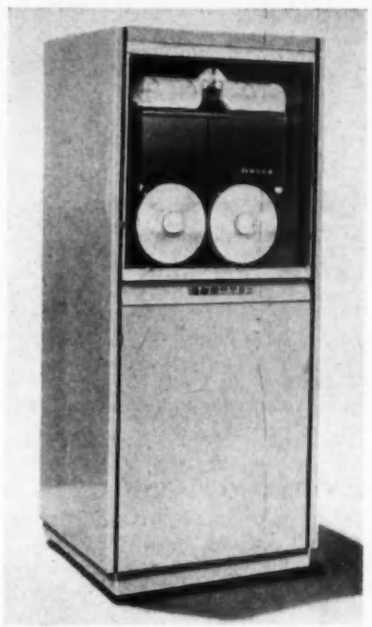


Fig. 8—Computer tape unit with pneumatic capstans allowing start/stop times of two milliseconds—Decca

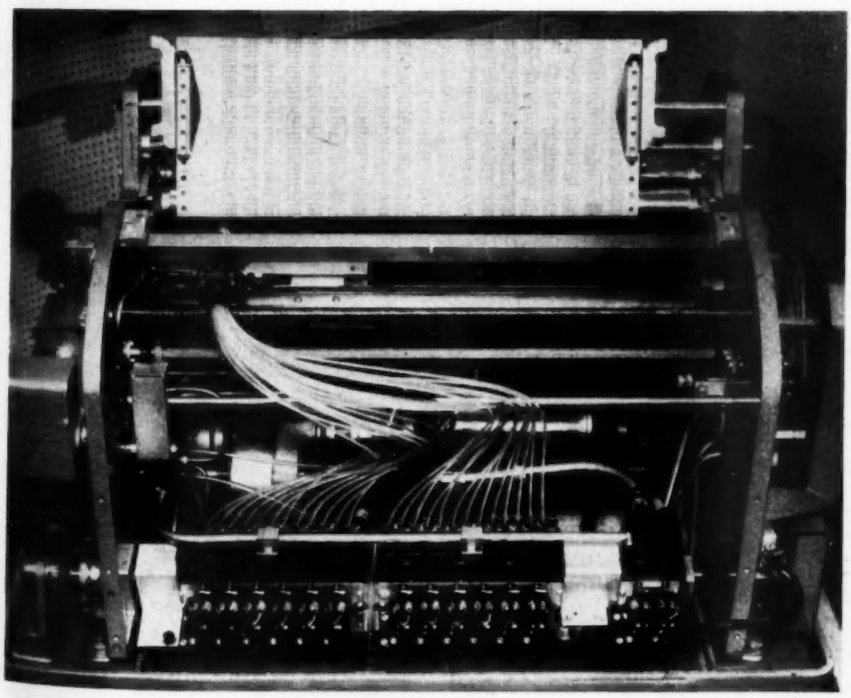


Fig. 7—High-speed output printer with " mosaic " character formation by means of a matrix of hydraulically-operated printing pins—Creed

Data Recording Instrument Company, Ltd.

High packing densities of information on magnetic tape, such as 3000 bits per 0·5 square inch, have increased the importance of uniformity and integrity in the powder coating. A complete automatic equipment for testing the integrity of magnetic tape before use was shown by the Data Recording Instrument Company, Ltd., 33, Woodthorpe Road, Ashford, Middx. The " Tapetester " 536 (Fig. 9) records test signals on the tape and detects the effects on them of blemishes such as nodules or pinholes. On detection of a flaw a pulse is generated which is either directed to circuits producing meter indications, or to the transport control circuits. In the latter case, which applies if visual inspection is desired, a marker pulse is recorded on the tape, which is then positioned automatically so that the flaw appears under a microscope. The "Tapetester" is designed to accept all known thicknesses of tape, and makes, in one pass, at 75in or 150in per second a full statistical analysis of all imperfections

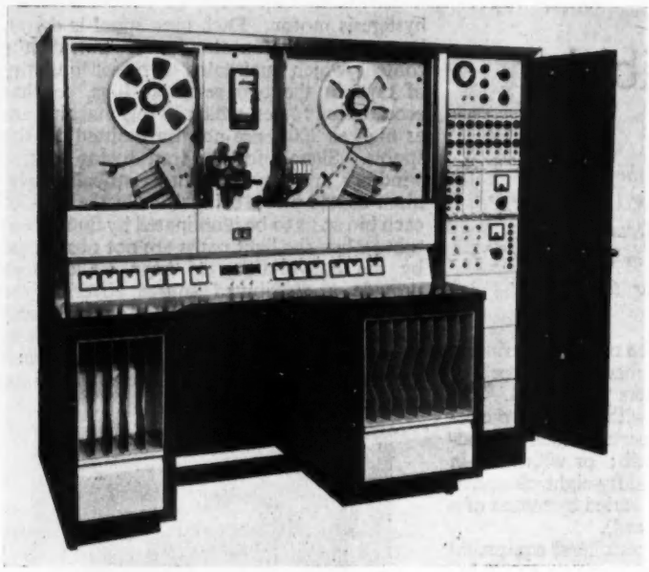


Fig. 9—Automatic equipment for detecting flaws in magnetic tape, with statistical display and microscope inspection facility — Data Recording Instrument Co.

falling outside the limits of quality set up on the control panel by the user. At the same time a pen recorder shows the mean sensitivity of the tape. The value of a specialised machine for tape testing can be seen from the fact that in some circumstances computers themselves have been used for this purpose. By lifting the tape off the read head, a very small nodule can cause a loss of many decibels, while pinholes may introduce noise pulses.

Short Brothers and Harland, Ltd.

We illustrate in Fig. 10 an educational analogue computer developed by Short Brothers and Harland, Ltd., Castlereagh, Belfast, primarily for universities and technical colleges, although also suitable as a laboratory machine having an accuracy of 1 per cent. Amplifiers, scaling and other units plug into the computer board, and the amplifiers themselves have front panel sockets to receive input and feedback components of various values. These plug-in units are in the form of boxes with slide-off covers carrying the symbol of the component they contain. Removal of the cover enables different values of capacity or resistance to be substituted rapidly. Four potentiometer scaling units with their adjusting knobs are also seen in the illustration. Interconnections are made by elastic leads, and guide pins inserted in the computer board enable the runs of the leads to be straight and well spaced so that a clear picture of the circuit in use is presented to the class. The computer will operate from any standard laboratory power supply and may be connected to a twin-beam oscilloscope or pen recorder.

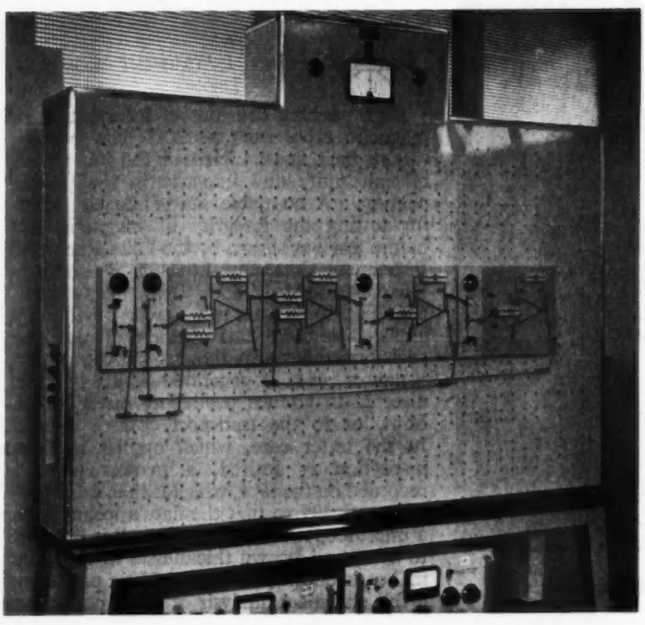


Fig. 10—Educational computer with plug-in amplifiers and components — Short Brothers and Harland

Automatic Telephone and Electric Company, Ltd.

Data transmission systems were featured by several exhibitors, and this aspect was supported by exhibits on the Post Office stand relating to its data transmission facilities. Among the companies supplying terminal apparatus which is approved for connection to normal G.P.O. telephone lines is the Automatic Telephone and Electric Company, Ltd., Strowger House, Arundel Street, London, W.C.2, one of whose terminals is shown in Fig. 11. These incorporate the A.T.E. "Swift" transmitting or receiving equipment together with the logical circuits controlling and manipulating the information. A tape reader (or tape punch at the receiving end) is supplied with the terminal, together with a telephone instrument. Information is fed to the code converter of the transmitter as a binary, square wave signal. This waveform is converted into a two-level signal representing "1" as a change in level, and "0" as no change in level, and the signal thus recoded, phase-modulates a 1500 c/s sine wave carrier. At the receiver a differentially-coherent mode of detection is employed in which each signal element is directly compared with the one preceding it, by delaying the latter. If it is decided that two elements are on average the same, a "0" is indicated, and if it is decided that on the average they are different, a "1" is indicated. The method described is stated to give the "Swift" receiver the maximum possible tolerance to frequency variations in the received signal with only a small reduction (0·5 dB) in tolerance to noise relative to more conventional coherent

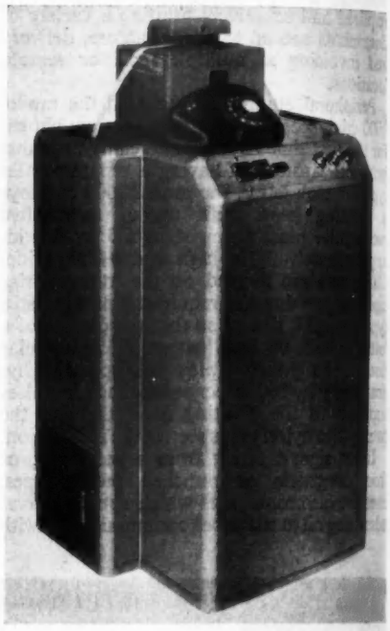


Fig. 11—Transmitting terminal for medium-speed data transmission from punched tape, using telephone or radio circuits—Automatic Telephone and Electric Company

detection methods. Timing waveforms are available at the transmitter and receiver to synchronise the associated logical circuits. Error detection is on the parity bit system. When a discrepancy is detected at the receiving station, the monitoring tone signal which is fed back continuously over the data circuit to the transmitter is switched off, warning the operator there to retransmit the message. Automatic correction of the more likely errors can be included if required.

Elliott Brothers (London), Ltd.

A full-scale model of the Elliott 503 ultra-high-speed digital computer for science and industry was shown by Elliott Brothers (London), Ltd., Computing Division, Borehamwood, Herts. This equipment will be nearly 100 times faster than the present 803 computer, largely as a result of operating in the parallel instead of the series mode, and replacing the core logic by semiconductor logic circuits taking advantage of the latest developments in transistors and diodes with fast switching times. The capacity of the

core store will be twice that in the 803. Basically a 503 installation comprises the central processor cabinet, a paper tape station and a control desk. Construction is on the modular principle. A three-module cabinet houses the central processor and power supply with room for a peripheral transfer unit when required. Each controller for peripheral equipment occupies a single module and is made up with a power supply unit in a two-module cabinet. The controller for the Elliott card reader is housed in the desk on which the reader stands.

A demonstration on the stand showed the Panellit 609 industrial information and computing system working in conjunction with an 803 computer to produce operating guides, yields, partial and overall efficiencies, and similar data from a process plant. The computed data can also be used for the direct control of the plant.

Associated Electrical Industries, Ltd.

As a result of the recent agreement between A.E.I. and Facit Electronics, A.B., of Sweden, the Facit random access magnetic tape memory, high-speed tape punch, and high-speed tape reader were shown for the first time in this country on the stand of Associated Electrical Industries, Ltd., Crown House, Aldwych, W.C.2. The memory comprises sixty-four magnetic tape reels located on the periphery of a rotary platter. When a reel is addressed, the platter swings the chosen reel into the operating position by the shortest route. The free end of the tape is weighted, and when the reel reaches the operating position, the weight falls through guides, leading the tape past the read/write head. A pinch roller presses the tape against a continuously rotating capstan which winds the tape off the reel into the reservoir. Reading and writing are performed during this unwinding process. An external order starts the rewind, and when this is completed the station is ready for the next operation. Advantages claimed for this small reel system are easier initial assembly of data, rapid acceleration and deceleration of the tape without requiring a servo system, and short access times for all data.

The Facit tape reader is an all-transistor device in which the characters are sensed by the variation in capacity between an electrode and a series of probes dependent on which probes coincide at any moment with punched holes. The system forms a variable capacity in a tuned circuit, of which the resonant frequency represents the characters to be printed out.

African Science Film Congress

(Contributed)

THE Fifteenth Congress of the International Scientific Film Association was held in Rabat from September 16 to 27—the first convention of its type in the African continent. It was natural that attendance from other continents should be smaller than in previous years, since Rabat is not as accessible as European capitals ; but it was a disappointment to find that African representation was confined to a large Moroccan delegation (second only to the British which had twenty-three members) and only single representatives from Mali and Guinea.

I.S.F.A. Congresses always provide a unique opportunity for seeing scientific and technical films of high calibre from many countries, and if Rabat total numbers were smaller than in previous years 165 films from twenty-one countries still represents a formidable assembly. Unfortunately the conventional arrangement of having Popular Science Film Festival programmes (open to delegates and the general public) supplemented by Section meetings for delegates which run concurrently limits one's opportunity for seeing as many films as would otherwise be possible. Moreover since the three Sections—concerned with Research, Education, and the Popularisation of Science—inevitably have overlapping interests, and since individual delegates themselves may be professionally concerned with films in more than one Section there is a strong case for a future rearrangement of the timetable.

The balance of subjects presented on films tends to vary from year to year. This year, for example, both the French and the Bulgarians had films on the total solar eclipse of February last ; the latter a typically economical and effective popular presentation of the kind previous Congresses have taught one to expect from this comparatively new film-making country. It was the Bulgarians too who won one of the Diplomas in the Popular Science Section with their film "A World in a Waterdrop" (one of three films on this subject), with its beautiful cinemicrography.

Each Section offered Diplomas for what were considered the best films, and of the twenty-six awarded only one went to Great Britain, for A.E.I's new film "Electron Microscopy—an Introduction." British Transport's "Wild Highlands" (latest of the beautiful Ralph Keen nature films) got a special mention, as did two Japanese films —"In Pursuit of Cancer Cells" and "Lubrication"; whilst the Japanese entry as a whole was given a special award by the Moroccan organisers for the national entry which best reflected the interests of I.S.F.A.

For the engineer there was much of interest. In the British entry were British Transport's "Experiment under London," a neat study of the drilling of the experimental tunnels by London Transport, with a very clear description of the ingenious drilling machine which cuts the complete tunnel section in one continuous operation. A.E.I. also displayed "Analysis of Solids with the MS7 Mass Spectrometer"—welcome not only for its subject matter, but also as a practical teaching film which makes no concessions in getting its information across. Shell's "Free Piston Engine" is a characteristic example of that company's mastery of instructional film technique, with its ingenious yet simple animation and its wedding of good visuals to clear commentary. At the other end of the scale British Oxygen's "O is for Oxygen" is an example of the very sophisticated public relations films, sound fare for the film critic but a little less satisfying for the technically informed. "The Ways of Water" (an account of the work of the Hydraulics Research Station at Wallingford), "Outline of Detergency" (Unilever's masterly exposition of a difficult subject for general audiences), and "Prelude to Power —the story of Faraday and the Induction Ring" (an example sponsored by E.F.V.A. of West European co-production) were other notable British entries.

The Italians had two very competent examples of reportage "The Bridge on the Reno" and "The Viaducts between Rioreggio and Serra Ripoli," both notable for some excellent photography ; whilst Fiat's "Tolerance Zero" was an imaginative account of the research behind and design of a modern mass-produced car.

The East Germans have an enviable reputation as technical and scientific film makers and their entry this year was well up to standard, and in particular remarkable for an historical study "Robert Koch" which successfully avoided most of the pitfalls of the period reconstruction film and which, if dubbed in English would have a wide audience here. Another of their films "Shapes and Colours" presented an interesting study in industrial design, showing in particular the evolution of the design of a 16mm film projector.

Best of the Dutch entry, and already in distribution in Britain was "Hold Back the Sea" a dramatic account of Holland's long battle with the sea, leading up to a brief account of the progress being made with the imaginative Delta Plan. The Dutch won two Diplomas in the Research Section with "Flow of combustion gases in the chamber of a ring kiln for brick firing" and "Improvements in chamber-drying with model tests", with its study of air flow patterns.

In the Soviet Union films play a major part in training and popular education and contrasting examples were to be seen in their Diploma winning film "Colour Television" which because of its excellent visual presentation made the principles clear to a correspondent who could not understand the Russian commentary, and "The Clutch" one of a series of instructional films for tractor drivers.

One quickly learns at conferences of this type that effective film-making is no longer the prerogative of a few countries. It was the Poles who won an award with their very imaginative study "In the Gulf of the Polar Bears" whilst the Belgians had made the best film your correspondent has seen on an antarctic expedition ("In the Very South"). Whilst the Czechs could produce a useful film record of experiments in human reactions to weightlessness in an aircraft flying on a carefully plotted course the Rumanians could enter a very novel film on "Element 14—Silicon" which used ingenious animation and a nice touch of humour to get across some useful chemistry.

I.S.F.A. was from the beginning an international body representative of nations of all colours, creeds, and ideologies, and it was appropriate that the Russian President of an old member-country should announce the entry of a new member at Rabat—the United States. It was characteristic too that the American delegation should withhold the screening of their film on Sheppard's space flight as a friendly gesture to the Russians, whose film on Titov had got snarled up somewhere in the red-tape which still frustrates the free flow of cultural films throughout the world. This Congress, like its predecessors, has shown there are plenty of good films for specialists in every subject. What the specialists need is easier access to them.

Institute of Navigation.—The report of The Institute of Navigation for 1960–61 notes that the membership has increased by 133 to a total of 2016 and states that the Gold Medal for 1961 has been awarded to Mr. Francis Chichester for his outstanding feats of single-handed navigation at sea and in the air. The Bronze Medal has been awarded to Mr. E. S. Calvert for his paper "Manoeuvres to Ensure the Avoidance of Collision," while the Institution's trophy has been won by Pilot Officer R. E. Williams.

The Institute of Marine Engineers

On Tuesday, October 3, Mr. C. C. Pounder gave his presidential address to The Institute of Marine Engineers at the Memorial Building, Mark Lane, London. He gave the title "The Marine Engineer and the Common Life" to his address, abstracts of which we reprint.

MY essential duty, as this year's President, would appear to lie in endeavouring to stimulate the interest of members in the work of the Institute and in our profession, thus providing an exordium to next year's events.

In all communities of sentient things the chiefest care must always be for the young. In this Institute we are singularly sensitive to all matters relating to the training and care of young men before and after they enter the profession. Expressed another way, it seems to me that a useful purpose would be served at this juncture if I could transmit to young men some notions that might be useful to them in their approach to the everyday life of engineering. And so I have called this address "The Marine Engineer and the Common Life." It chiefly consists of random comments and expressions of thought of an engineer who is a general practitioner.

The Institute of Marine Engineers is not a building, it consists of all those men on its register who, at this moment, are vocationally occupied on all the oceans of the world and in all the maritime districts of the habitable globe. Within a couple of decades the Institute can be expected to become, financially, the strongest engineering institution in the country. Resulting therefrom, problems will arise that will require the highest statesmanship for their handling. For every 1000 men who can endure the lashes of adversity I doubt if there is more than a single solitary man who can satisfactorily withstand the corrosive consequences of success. As the financial picture unfolds and the Institute feels more and more a sense of trusteeship it will, I doubt not, look towards the great Dominions and the countries of the Commonwealth for wider opportunities of service. In the counsels of such an Institute there can be no place for the Little-Englander.

Looking to the future : as the work of the Institute grows and expands, self-sustaining power will be increasingly required in, at least, the larger branches. The problem then will be to ensure that the complete system will at all times function smoothly and healthily. This requirement implies not only the total absence of supineness at headquarters, but an ever-present consciousness of being *en rapport* with everything affecting the wellbeing of members everywhere. For the branches, a correct degree of autonomy will be essential for each centre ; the ultimate strength of our position, in the Institute, lies in the fact that we apply ourselves only to one department of engineering, namely, marine engineering. This makes for a fellowship of interest not possible otherwise.

In formulating requirements for Institute membership it is unavoidable that qualifications, practical and theoretical, should be laid down fairly closely. But I hope the rules will never become so rigid nor their interpretation so hidebound as to exclude the very unusual man who, by the application of the rules, would be ineligible for membership although possessing countervailing talents of a very high order.

When the period in which we are now living comes to be mentioned in the history books, it will surely be described as the Age of the Busybody. Our twin industries of shipbuilding and marine engineering have, within the past year or two, received special attention from the busybodies of the lay press. One of the depressing features of ill-informed criticisms of our industry is the bad effect they can have upon engineering opinion in Continental countries, upon men who are friendly to us, who have British licence arrangements and who desire to continue with those licences. We may ourselves tolerate stupid articles in the newspapers because we know how valueless they can be. But these same criticisms, these same comments, read and pondered by responsible and serious engineers in other countries, are too often interpreted as showing that British marine engineering is tending to falter—which it certainly is not !

What, I wonder, would be the response of these literary leprechauns if an all-challenging Voice came to them, as it came to Job out of the whirlwind and said : "Who is this that darkeneth counsel by words without knowledge? Gird up now thy loins, like a man ; I shall question thee and thou to me must answer."

Against the technical press little or no criticism, in my opinion, can be made. A cheap cynic might say that these papers—some of them not very powerful when measured in terms of circulation—are dependent upon shipbuilding interests for the advertisement revenues by which they live. That is not the explanation. The most able of all the technical editors whom I have known or heard about said, on one occasion, that no amount of money spent in the advertisement pages of his paper would buy favourable opinion in the editorial columns. People advertised in the paper because they obtained commercial value therefrom, as a separate transaction. They would never receive editorial mention because of that fact. I have no reason to believe that this code does not continue to be upheld by the editors of our technical papers. Some of these editors are naval architects by training and experience ; others are marine engineers, some of them being chief engineers and extra-chief engineers. Accordingly when they write they write with knowledge.

The subject of research probably attracts more irresponsible talk than does any other subject. Whenever a problem arises somebody suggests that there should be research upon the matter, preferably an *ad hoc* research, with much liaison about it. Politicians, especially, are prone to take advantage of the fact that nothing has a greater hold on the human mind than nonsense fortified with technicalities. With correct penumbra of meaning, to research means to search again. In the everyday Elizabethan speech of Ulster the word always receives proper pronunciation. It is called "*re*-search". Many of us spend one-half of our lives in re-examining the problems of design, of production, of first cost, of maintenance, always with the impelling desire to improve, to simplify and to make less costly. Looking forward to the next few years, for both steam turbines and heavy oil engines, I cannot see anything more spectacular than steady, fractional improvements year-by-year. Unless I am mistaken, there is nothing that requires the kind of upheaving research that uninformed outsiders facilely suggest. A careful examination of the position shows that the amount of research work being done by our British association is double that of all the similar research associations of seven Western European nations put together.

One of the drawbacks of research is the small scale on which much of the work has necessarily to be done. Men in research establishments are apt to minimise the consequences of scale effect. In the application of the results to large engines, most experiments on small-scale models can only be interpreted qualitatively.

A strong case can doubtless be made for Governmental aid to assist the researches of many of the newer, rapidly developing industries. But marine engineering is at a different stage of development. What, for example, do member firms expect from the industry's turbine research establishment, i.e. the Parsons and Marine Engineering Turbine Research and Development Association? The short answer is : we require turbine and gearing basis plans. Into these plans are woven the results of the researches which are continually being made and which affect all components of the designs. But it is *designs* that we require, not journals of researches. In this respect Pametrada has always differed from other research associations that receive Government grants. If our organisation is really to be increasingly effective for our purposes it should be freed from Government assistance. What it does should be determined entirely by our member firms. If this were the pattern, the Association, as now evolving, could quickly become a bastion of strength to the industry. In my opinion it is unsatisfactory that development programmes should have to be distorted for ensuring compliance with conditions necessary to attract fractional Government aid.

The critics of our industry should, at least, learn to speak with consistent voice. On the one hand they suggest that British marine steam turbine builders should seek licences from other countries or from land firms. On the other hand they complain that heavy oil engine builders go outside of the United Kingdom for their licences instead of pursuing what is said to be a native design.

Marine steam turbine practice in this country is based upon Pametrada designs. This Association belongs to the marine turbine builders ; all its affairs, technical and commercial, are determined by them. It is therefore—and very literally—their servant. If the results are satisfactory, the overall credit is due to the member firms ; if they are unsatisfactory, the blame is, also, entirely theirs. Since its foundation seventeen years ago, Pametrada has grown in influence and value to such an extent that its mercantile designs are specified by shipowners almost automatically. From time to time, criticisms are levelled against it : of course they are ! I have made it a rule to pursue every criticism of Pametrada designs that comes my way ; and in the face of an impartial array of facts the Pametrada reputation—so far as I am concerned—remains unsullied.

Regarding the criticisms that have been made about the number of British builders who have allowed themselves to become dependent upon Continental licences for marine heavy oil engines : I fail to see any adverse significance in this fact. Shipping is international in its scope and worldwide free trade must always be its ideal. We live in a

century of intense nationalism and anything that circumvents or transcends nationalistic feeling, anything that tends to break down barriers between nation and nation, is surely to be commended. As an example of the extent to which we are designers of the engines which we build : our current engine type, which has proved to be very successful, was designed during the later war years. The weight and value of the continuous technical contribution which Harland and Wolff have made over many years to the development of the marine oil engine has no equivalent in Britain. But because we are licensees of another firm, everything we do is perforce associated, in the minds of outsiders, with that licence.

It is a disadvantage of the licence system, as ordinarily devised, that everything that is invented or developed by the licensee must be declared to the licensor, who has the fullest right, not only to use the information himself, but also to pass it to other licensees who may well be strong competitors of the originating licensee.

The only point that does matter is that we should have steam turbines and heavy oil engines of a high order of excellence to build, that these machines should be a credit to their builders and to their owners, and that they should yield to both a reasonable profit.

Now to turn, for a space, from some of the ponderable objects of the engine-room to some of the imponderable problems of the engineer, especially the young engineer. When not directed to matters more immediately associated with his livelihood, a normal engineer's thoughts can be expected to stray, occasionally, to considerations of future success, of professional status and kindred matters. What is success? It may be stated at once that if, in any man's mind, success is a synonym for moneymaking, then he, the success-seeker, should turn his back upon marine engineering and seek enterprises elsewhere. Success is a complex aggregation which contains innumerable elements and sub-elements. The summation must take into account all the circumstances at both ends of life. It must take into the reckoning such matters as inheritance of physical, mental and moral health, material possessions, circumstances of climate, domestic life and so on.

I seriouly doubt if, when resolved into ultimate values, there is very much to choose, basically, between one life and another. I have been the repository of the confidences of many so-called successful men ; but there has almost invariably been something out of sight, that has vitiated their contentment. Once in a long while a mass-produced precision machine may have all the tolerances leaning in one direction, resulting in a machine which is too slack or too stiff and which defies alteration ; similarly once in a million times there may appear a man whose path from the cradle to the grave is petal-strewn, or vice versa. But this is not the norm.

It seems to me that in most normal lives a man has to be ground between the upper and the nether millstones of fate in order to obtain some kind of training from life. If that be so, it is far better that the first half of a man's life should be hard, to ensure that the second half is more reasonable. From the nature of things, great numbers of men must perforce spend their lives in routine occupations. It is well for the stability of society that most of them do not desire the shouldering of responsibility. But there are some who fain would break the bonds that bind them to their circumstances. Those that do not, or cannot, escape are to be numbered amongst the unfortunate.

It is important that a young man should not jeopardise his chances of success by grasping at prizes outside of his reach, but must shape his ambitions to fit his talents. There are some men who are rightly appointed to high office exclusively because of their inherent ability. But most men who achieve apparent distinction are where they are by the operation of many factors, only one of which may be innate ability. Other factors may be that they were available at the time the appointment was made and were not unsatisfactory ; that they could be relied upon not to leave the firm ; that their salary expectations were not too high ; that they would always be loyal ; that they had been about the place for a long time and under their leadership things were not likely to be drastically altered. Nepotism, under one of its many guises, can explain many appointments. A man's position and influence can depend far more upon the accrued early advantages of position, family influence, and so on, than upon merit, If men are honest with themselves they must admit that their high positions are due less to sheer merit than to a concatenation of circumstances.

In general terms, if a man is to succeed professionally he should, fairly early in life, determine what it is that he will make his speciality. Then, with study and practice, he should make himself as nearly perfect as possible in that field. The man at the top of a large and complex organisation cannot remain a specialist ; he must develop into a general practitioner. A man may be brilliant, energetic and many other things ; but it is judgment that tells. To have to stand at the point where all technical problems meet, to sort them out and determine the right answer, the right course to pursue, is a task that requires calmness. Hustle is not work ; it is the enemy of work.

Of the many things that assist in making or marring a man's work-a-day life, there are three that are outstandingly important. These are, respectively : (i) the type of leadership he is given ; (ii) the frustrations to which he is subjected ; (iii) the personal code he follows. It seems to me that every man is inescapably bound and suspended by this threefold cord.

Almost every problem becomes a challenge to leadership. Therefore, in seeking the right man for a high position, no effort can be too great in determining the result. Some men have a natural aptitude for choosing the right man for a post ; in other men the place of aptitude is taken by prejudice, by susceptibility to caste or class, and so on. It is impossible for an establishment to remain continuously efficient as a productive body, or to be harmonious as a place in which to work and live, unless at the top there are executives who possess in generous measure the attributes of wise judgment and long vision, and who are of the correct calibre as leaders, with the right moral fibre as men. There are very few men indeed who do not respond to able leadership ; and there is no commodity that is so readily available as loyalty, if the leader himself is fully loyal to his followers. Persuasiveness is a far more effective weapon than domination in dealing with intelligent and reasonable men.

In an effectively run firm there is no room at the top for the bully, nor for the habitual bluffer, nor for the little fellow who is everlastingly " harping-on " about trivialities.

In other days leadership was often synonymous with bullying and overbearing truculence ; that is now seen to be the prostitution of leadership. The great hustler, the man of ruthless drive, the man with a bark in his voice : these men are not leaders. Inexhaustible energy ; indomitability of spirit : these are only of value when linked to high intelligence.

High amongst the requirements for successful leadership must be numbered energy and knowledge ; which must both be present, simultaneously, at all required times. Knowledge without energy can lead to lethargy ; energy without knowledge means turbulent inefficiency. Intelligence, by itself, can be overrated. Intelligence is inherent ; but energy, industry and willingness can be cultivated, and these are very important attributes, especially for men who are conscious of their limitations in intelligence. An able man runs his department, or his firm, always within the limits of his physical and mental capacity. For a man to behave otherwise means that he has no reserve of energy, or nerve, for those sudden, almost overwhelming problems that can arise from time to time.

Frequent frustration is the common experience of all men who put their shoulders to the wheel of progress. As such, it must be accepted as part of the discipline of life. If a man has no conflicts to overcome, no difficult problems to resolve, no malicious, shallow, untruthful or stupid people to circumvent, or if he is never stretched on the knife-edge of suspense, then he is learning nothing from his journey through life and he bears upon him no characteristic diacritical mark.

Sooner or later every man comes to be identified with an ethic. It was borne in upon me early in life that, for me, the only force that ultimately mattered was in the voice of calm reasonableness that continued to lead and to direct long after all incidental feverish tumults had worn themselves out. My own ethic is simple in structure. Its first element is concerned with truth of intercourse. A skilful politician seldom speaks with single-mindedness. Seldom can he be pinned down as having uttered a clear unequivocal unambiguous statement. There is always a second, alternative, story, cleverly implicit and latent in his main story, upon which he can fall back if expediency so requires. For the engineer there can only be one code, namely, literal adherence to fact. This procedure makes life simpler and more straightforward than it otherwise would be. The next element is concerned with adherence to one's word. All this leads up to the extremely important matter of confidence between man and man. The creation of a state of abiding mutual confidence can take a long time, but, once established, it can be a source of great strength and value to those concerned.

The need for the better education of engineers is an unceasing topic of discussion, but a greater and more clamant need is for the public to be educated to understand the inestimable value of engineers as a national asset.

A clear discrimination between fact and opinion is at all times necessary. In the course of an investigation it so often happens that a man uncovers facts ; he then proceeds to select only those facts which, to him, are significant. This done, he begins to form an opinion. As soon as this happens he too frequently starts to interpret his chosen facts in the light of that opinion. He thus ceases to be an impartial judge of facts. Facts can themselves be meaningless ; it is only the interpretation that may be given to those facts which counts. But the opinion, the hypothesis, the theory, must embrace all the facts.

The ponderous Foucault pendulum of destiny is always inexorably on the move, it is only the amplitude of the swing that varies. Many of the problems with which we are confronted are not things that have suddenly emerged from nowhere. They are the consequences of the swinging pendulum. Yesterday the capitalist masters were the tyrants ; to-day the position is largely reversed and the workers' unions are the tyrants ; to-morrow, on the next re-swing, the servants of the State may be the villains. Yesterday there was not a vestige of security for the working man ; wages were determined by the length of the queue of hungry men outside the factory entrance. Now, at the other end of the swing, thousands of fertile people live parasitically on the State at a higher level of comfort than that obtained by working.

One of the chief characteristics of our times is that we think in terms of great masses of people all living around a common denominator of material comfort. Material prosperity, however, is not the beginning and end of life. According to recent authoritative statistics, the standard of living in Scandinavia is greater than it is anywhere else. Everybody is safeguarded, in one way or another, from infancy to old age. Yet, in one of the countries, the rate of mental illness is the highest of any country anywhere ; in an adjacent country the suicide rate is the greatest in the world. A consideration of these and similar facts makes it clear that in our materialistic civilisation something in the nature of a spiritual vitamin is lacking.

Many young men say that the State owes them a living. The State is simply the sum total of ordinary citizens ; the correct answer, therefore, is that the State owes them nothing.

In marine engineering there is no such thing as practising art for art's sake. Shipping is one of the most unsheltered and most competitive businesses in the whole of the world. The underlying, persistent, urge to marine engineering progress is, therefore, always economic.

Critics of our industry, in their exuberant advocacy of the obvious, tell us that we should be standard-minded. Quite ! It is not in the main propelling units, be they oil engines, boilers, turbines or condensers, that the greatest scope for standardisation and simplification lies, but in the machinery and pipe arrangements. In passenger vessels and cargo liners the weight of the machinery pipework is 0·20 to 0·25 that of the main engines ; for tankers the ratio is 0·21 to 0·27 ; for cargo ships the ratio is 0·23 to 0·33. The cost per ton of the pipework relative to that for the main engines is, respectively, 1·6 to 1·8, 1·7 to 2·2 and 1·3 to 1·7, for the same categories of vessel as before. The ratio of cost of pipework to cost of main engines, for the same sequence of ships as above, is respectively 0·35 to 0·375, 0·44, 0·35 to 0·45.

Having stated that the cost of machinery pipework can be 35 to 45 per cent of the money value of the main engines—a fact which will come as a revelation to many outsiders—what are the channels along which reductions can be made? They are two in number. First, there is the reduction in the diversity of pipe bores and thicknesses and, more especially, in the variety and sizes of valves and fittings. Second, there is the reduction in the numbers of cross-connections and duplicate pipe systems. The first-named is the task of the engine builder ; the second is the affair of the shipowners, the classification societies and the Ministry of Transport.

Second International Machine Tool Design and Research Conference

By HUGH CLAUSEN

THE success of the first Machine Tool Design and Research conference at Birmingham University last year was well confirmed by the second one, organised by the engineering department of the Manchester College of Science and Technology, which took place there the week before last. There were about four hundred present, approximately equally divided between industrial and educational backgrounds. This balance was not reflected in the sources of the papers presented, where industry only reached to about 10 per cent of the total. This was at least a welcome—albeit a small—advance on last year, when there were no industrial papers. It would appear that you can take the machine tool engineer to the conference, but that you can't make him speak!

A stimulating address of welcome by Dr. Bowden, the Principal of the College, was followed by a rousing call to the industry by Sir Steuart Mitchell to show a more adventurous and enterprising spirit. As far as the industry itself is concerned however, its prosperous state since the war, with full order books, good industrial relations, and the ability to sell pretty well everything it makes, may well have led to reluctance to undertake much new development work. A common criticism of the industry in the recent past has attributed its lag behind Continental or American practice to the very small numbers of graduate engineers employed in it. A counter which could well have been made—but which I have not heard expressed—is that the universities have not, until the last year or so, taken sufficient interest in the important basic mechanical engineering work involved in machine tool design to turn out graduates who could have been of any help or value to the industry. Research in this field only provides the raw material for design, and is only of value in so far as it may lead to widening the field, or improving the quality, of design.

The gap between the science of metal cutting and the art of machine tool design, which was the outstanding impression of last year's conference, remains. There are, however, indications of a rate of change of this gap ; and this effect, integrated over a few more years, may perhaps help to close it.

This annual conference is likely to be an important factor in acting both as an error signal, and as a stimulus to action. The industrial prosperity of the country is more dependent on this proper integration between the sciences and the industrial arts than on any financial or economic measures that the Government may take.

There was an impressive international component, both in the papers presented, and in the attendance, and the international character of the conference seems to be growing. An appreciable number of the papers seemed unworthy of the occasion ; some in respect of the nature of the material presented or the work described ; others from poor presentation, inaudibility of the lecturer, or poor quality slides. Whilst poverty of material cannot be compensated for by capable presentation, good ideas may fail to get across owing to the lack of it. A copy from a book illustration or a typewritten table of figures rarely makes a slide suitable for showing in a large hall.

As usual, many of the lecturers over-ran their time, and prevented useful discussion, often the more valuable part of a meeting. Not all the papers aroused discussion, but for some which did, the lack of time was severely felt, and some days became less of a conference than a series of lectures. Although entitled a Design and Research Conference there were very few papers with any appreciable design component in them, and, as might be expected, these came from industrial sources. Lack of appreciation of design problems was apparent in the experimental gear described and illustrated in some papers. Much closer collaboration with industry, or with some source of design ability, seems to be needed before an educational or research establishment can make an effective contribution in real, practical applications.

One afternoon was devoted to visits to the works of machine tool manufacturers in the neighbourhood of Manchester, of which a wide choice had been arranged. I should like to have visited many, but my choice gave me, in going round the drawing office, pattern shop, foundry, machine and erecting shops, under expert guidance, just what was wanted to balance the conference papers ; an even fuller appreciation of the practical skills, and the depth of experience needed, to bring the ideas of the scientist to effective fruition. The means to bring out effectively the importance, and the depth of thought involved in these matters still seems to be beyond the reach of the universities.

It was interesting to meet some of the past and present students of the Course of Machine Tool Design at Manchester College of Science and Technology, now current under the Professorship of F. Koenigsberger with the support of the Machine Tool Trades Association and the D.S.I.R. There seemed to be some special significance in holding this conference in a town, and a street, so closely associated with Joseph Whitworth. He was a very farsighted man, with a full appreciation of the importance of combining engineering experience with scientific and general education. The first Whitworth Scholarships were awarded in 1869, and one of the first students was John Hopkins, of the engineering school of Cambridge University. Whitworth died in 1887, and it is an interesting thought that since his time, no one—except in the last very few years—has thought fit to follow his lead in giving such substantial support to that essential integration of the sciences and the industrial arts. He has had—in fact—no successor. The last few paragraphs of Whitworth's biography in the *Dictionary of National Biography* should be read by every engineer.

In spite of all this criticism, there is reason for a hopeful outlook. There is plenty of potential talent in the country, not always in the places where one might expect it ; and the last few years have shown some good progress in the development of computer controlled machine tools, some of the best of it right outside the machine tool industry. All those concerned with the organisation are to be congratulated on the success of the arrangements : and provided that we realise that we have nearly a hundred years of leeway to make up, and follow Whitworth's spirit in our efforts, we should approach the future with confidence.

Letter to the Editor

WATER GRID USE OF EXISTING CANAL SYSTEM

SIR,—Further to the interesting correspondence in your columns on water supplies from the old canals, you might be interested to have a report of the extent to which existing canals might be applied to serve as a water grid. This would be, I think, the first time such evaluation has been published.

The term " grid use " will be taken to mean regional delivery over more than 50 miles, to draw the distinction against local uses. First then, the level reaches of canal not far from 300ft, between Llangollen and Wolverhampton, could be completed by a 10-mile pipeline to serve as a conduit, which with relay pumping could convey water from the River Dee to the South Staffordshire area.

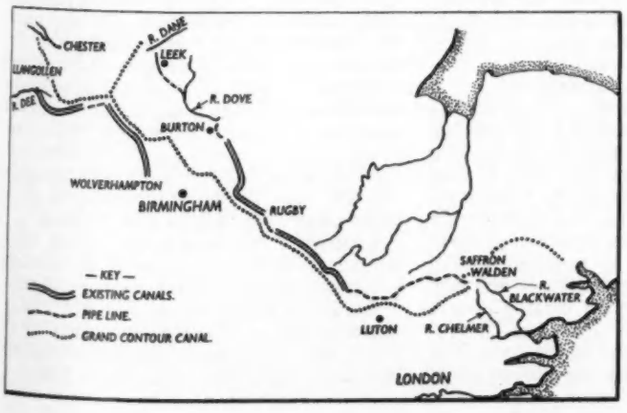
For the more difficult case of Essex we might look north westwards to the nearest upland area, the Peak district, whence issues the River Dove, to which some water from the River Dane might be added, using old canals and feeders. From the Dove at its mouth, a pipeline and pumping could bring water to the Ashby Canal, whence the existing canal system—though with a pipeline by-pass to Braunston summit—could convey the water through to Fenny Stratford. Eastwards from here, a pipeline designed as an ultimate grid irrigation distributor, and grading down to about 200ft, might be constructed early to deliver some water, with pumping, over to the River Chelmer and so to Essex.

This is about the extent of the " grid " use of the existing system, and the delivery rate with economical relay pumping would be about 60 cusecs, which, however, is only about 3 per cent of the delivery required of a complete water grid, about 2000 cusecs, as I have allowed for in my Grand Contour Canal plan. Such use then of existing canals is limited, but useful in early phases because it would be easily arranged.

J. F. POWNALL

Cardiff,

September 30, 1961.



Suggested connections between canals and rivers compared with the course of a proposed " Grand Contour Canal " from Cheshire to Essex

Books just published

London Beneath the Pavement
280 *pages. Illustrated.*
Publisher: Peter Davies, Ltd. 1961. *Price* 25*s.*
by MICHAEL HARRISON.

This is primarily an historical book which deals with subterranean London and its development on ground-level as portrayed by the remains and relics which are constantly being unearthed. The author defines London as the area bounded by Putney, Bow, Pentonville, Stoke Newington, Canonbury, Bermondsey, Vauxhall and Clapham. Chapters deal with, the foundation and development of London, beginnings of archaeology, mediaeval sewers and conduits, history of the water supply, development of the sewers, the lost rivers of London, Thames tunnels, underground trains, gas and electric mains, underground chapels, temples, treasuries and crypts, famous tombs, and a section on miscellaneous underground buildings. There is an excellent subject bibliography and an index.

[Reply Card No. 1200]

Static Fields in Electricity and Magnetism
255 *pages. Diagrams.*
Publisher : Butterworths and Co. (Publishers), Ltd. 1961. *Price* 35*s.*
by D. H. TREVENA, B.Sc., Ph.D.(Wales), Ph.D. (Cantab.)

This book, which is aimed specifically at university students, deals with three main topics, electrostatics, magnetism and magnetic fields of steady electric currents. The question of units, including M.K.S. units, the magnetic pole and magnetic shell have also been included with full discussions and worked examples. Chapters deal with units and dimensions, d.c. measuring instruments, introductory electrostatics, isotropic dielectrics, Gauss' theorem, capacitors, conductors, electric images, electrostatic instruments and measurements, magnetic shells and materials, and summary of results of the rationalised M.K.S. System. The book is completed by an appendix on solid angles, a short bibliography, answers to the set problems, and an index.

[Reply Card No. 1203]

Aufbau und Wirkungsweise von Ziffernrechenautomaten
161 *pages. Diagrams.*
Publisher : VDI-Verlag, G.m.b.H., Dusseldorf. *Price* 32*DM*
by P. NASLIN.

The present work is a revised German edition of " Principes des Calculatrices Numériques Automatiques " (Paris : Dunod, 2nd edition, 1960) which was written for advanced students as well as engineers in industry. After recapitulating the principles of digital computation, it deals with programming methods and the design of computers, including applications of transistors and magnetic circuits, and information stores, ferro-resonant circuits, parametrons, condenser stores and klystrons.

[Reply Card No. 1219]

Comparative Aspects of Restrictive Trade Practices : Report of a Colloquium organised by United Kingdom National Committee of Comparative Law, Southampton, July, 1960
91 *pages.*
Publisher : Stevens and Sons, Ltd., 1961.
Price : Paperback, 15*s.*, *Bound*, 21*s.*

The papers presented at this colloquium are given by eminent lawyers from European countries. The report gives a general survey of the laws relating to restrictive trade practices in the countries from which the delegates came. The papers included are, United Kingdom legislation on restrictive trade practices, United Kingdom approach to restrictive business agreements, observations on British restrictive practices legislation, law relating to restrictive trade practices in West Germany and the treaty establishing the European Economic Community, law relating to restrictive trade practices in Switzerland, Dutch and Belgian legislation on restrictive practices, brief summary of the law for the prevention of restrictive practices in France, and restrictive trade practices in Italy.

[Reply Card No. 1220]

Fundamentals of Engineering Science
800 *pages. Illustrations. Diagrams.*
Publisher : Hutchinson Educational, Ltd.
1961. *Price* 19*s.* 6*d.*
by G. R. A. TITCOMB, B.Sc. (Eng.), M.I.E.E.

This paperback is intended to cover the engineering science content of the new general courses in engineering which will be established following the Government White Paper, " Better Opportunities in Technical Education." The book intends to give the principles on which engineering is based, and is divided into twenty-two subject sections, which are further broken down in the text. These headings are, fundamental quantities and units, vectors, parallel forces, forces applied to solid materials, work and energy, friction, velocity and acceleration, force, mass and acceleration, angular motion and torque, power machines, atomic structure, heat, fluids, electric circuits, electrical measurements, electrochemistry, electromagnetism, alternating currents, electrical measuring instruments, energy conversion and engineering materials. The volume is concluded by useful tables, answers to set questions and an index.

[Reply Card No. 1228]

History of Invention
382 *pages. Illustrations. Diagrams.*
Publisher : Phoenix House, Ltd.
1961. *Price* 21*s.*
by EGON LARSEN.

The author attempts to give a comprehensive survey of man's technical progress from the earliest times to the present day. To do this, the book is divided into three sections—Energy, Transport and Communications, each of which shows the developments in its sphere up to the latest modern inventions. This book contains thirty-two pages of plates and 112 line drawings, and a relative index, which is necessary for finding specific information in this work.

[Reply Card No. 1230]

Atlantic Era, The British Atlantic Locomotive
94 *pages. Illustrations. Tables.*
Publisher : Percival Marshall and Co., Ltd.
1961. *Price* 12*s.* 6*d.*

The author of this book has attempted to outline the history of these locomotives. The book includes the history from the introduction of the first Atlantic locomotive in 1898 to the last journey of " Beachy Head," in April, 1958, and deals with the developments, experiments and trials of these engines, and is illustrated throughout with many pictures of them. Chapters include, the Ivatt Atlantics, Lancashire and Yorkshire 4–4–2's, North Eastern Atlantics, Churchward experiments, Robinson engines, North British Atlantics and the Atlantics of the L.B.S.C.R. There is no index.

[Reply Card No. 1231]

Lubricants for Nuclear Reactors

By P. E. B. VAILE, Associate Member*

No. I

At a meeting of the Institution of Mechanical Engineers in Chelmsford on September 14, Mr. P. E. B. Vaile, A.M.I.Mech.E., described the range of operating conditions which lubricants are expected to withstand in nuclear reactors, and particularly in carbon-dioxide-cooled graphite-moderated systems. He discussed requirements proposed by the U.K. Atomic Energy Authority for various applications and described test equipment for evaluating nuclear lubricants. After considering the effect of radiation on lubricants he dealt with the characteristics of some specialised nuclear lubricants and indicated some of the uses of conventional lubricants in reactors.

THE earlier power reactors in Great Britain, namely Calder Hall and Chapelcross, were designed to operate without lubricants, since insufficient was known of the effect on lubricants of radiation and high temperatures in an atmosphere of carbon dioxide, and since it was considered that many of the elements present in conventional lubricants would be incompatible with the "Magnox" fuel element cans. Such items as fuelling machines, control rod mechanisms, and chute machines were therefore designed to run dry.

Subsequently two factors led to a reconsideration of this position :

(1) Data became available in both Great Britain[1, 2, 3] and the United States of America[4, 5, 6, 7] on the radiation-resistant properties of various types of lubricant, which indicated the possibility of developing products to meet at least some conditions of reactor operation ; furthermore the composition of some of these products suggested that they would be compatible with reactor materials.

(2) The manufacturers of nuclear power generating stations for the British Electricity Generating Boards requested that wherever possible proved conventional engineering designs employing grease or lubricating fluids should be adopted.

Unlike the U.K.A.E.A.'s Calder Hall and Chapelcross stations these more recent stations are more basically power producers with plutonium as a by-product (and not vice versa), and this means that the reactors must run for longer periods under load. Consequently, examination and maintenance of moving parts is less frequent and it was therefore considered that, provided suitable lubricants could be made available, it would be preferable to use established methods of lubrication which would probably have the added advantage of saving production and/or maintenance costs.

United Kingdom Nuclear Lubricant Requirements

The U.K.A.E.A. has laid down certain requirements for nuclear lubricants, arising from a study of the above-mentioned operating conditions for British gas-cooled graphite-moderated industrial power reactors, and the knowledge that nuclear lubricants are now available with a continuing research programme in this field.

CO_2 Gas Circulator Oil Requirements.—These are shown in Appendix I. In effect the U.K.A.E.A. requires a turbine oil meeting BSS. 489 : 1955 which in addition will satisfy the CO_2 solubility, vapour pressure, and compatability requirements shown.

In view of the tendency towards higher oil temperatures particularly at seals, it may in the future be necessary to employ oxidation tests somewhat more severe than the current IP. 114/56 oxidation test at 110 deg. Cent. as specified in BSS. 489 : 1955.

The U.K.A.E.A. currently asks for the sulphur content of the product to be recorded, and although no limits are stipulated products having less than 0·5 per cent weight of sulphur have been favoured in the past ; however there are indications that U.K.A.E.A may be willing to accept higher levels up to, say, 1·5 per cent weight since practical compatability tests on oils containing up to 1·8 per cent weight of sulphur have been quite satisfactory. This will be beneficial since some of the more oxidation- and radiation-resistant turbine stock oils possess high sulphur contents.

Control Rod Mechanism Grease Requirements (*U.K.A.E.A. Schedule* 1).—The individual requirements for this application (Appendix II) are not too stringent, particularly in respect of resistance to radiation, and it is not too difficult to produce compatible products which will withstand irradiation to 5×10^5 rad without significant deterioration of physical and performance properties. The high-temperature (150 deg. Cent.) aspects of the bearing rig and volatility tests are probably the most difficult requirements.

However, the combined effect of these requirements, particularly the CO_2 and reactor materials compatibility aspects, almost certainly rules out the use of conventional soap thickeners, although it is still possible to utilise selected hydrocarbon mineral oils as base fluids.

General Purpose Radiation-Resistant Grease Requirements (*U.K.A.E.A. Schedule* 2).—This schedule covers the grease requirements of the fuelling and ancillary machines. It is restricted to maximum radiation and temperature levels of 1500 Mrad (over six months) and 200 deg. Cent. respectively. This will not therefore cater for all requirements and it is recognised that some items, such as fuel magazine bearings, may continue to operate without lubrication.

The requirements shown in Appendix III are extremely severe, and whilst it is possible to produce products which are compatible and which meet the drop point and worked penetration requirements up to irradiation levels of 1500 Mrad, and also perhaps the evaporation requirements, it is very difficult to formulate a product to pass the bearing rig test at the high temperature of 200 deg. Cent. in pressurised carbon dioxide after a high static irradiation of 1500 Mrad. Products have been produced which come near to meeting these requirements and no doubt they will be achieved in time. It is hoped that once this "target" schedule is attained, it will be possible to extend the radiation limits to permit lubricant change periods of longer than six months.

Effect of Radiation on Lubricants

The types of radiation which lubricants will encounter are gamma photons, and fast and thermal neutrons, all of which usually cause ionisation and excitation of the bombarded molecules. It is generally agreed that the damage sustained by a lubricant is the same for a given quantity of absorbed energy, irrespective of the type of irradiation[1]; this may not be strictly true under all conditions, but for practical purposes it is accurate enough, particularly when it is realised that some design estimates for radiation levels are only accurate to a factor of 10.

For convenience, therefore, in this article all radiation levels are quoted in rad.

Although the principal form of radiation encountered by lubricants is gamma, it should not be forgotten that neutron bombardment can cause induced radioactivity in the lubricant. This induced radioactivity will vary in degree according to the composition of the lubricant ; for example, it is developed to a higher degree in oils of high sulphur content. It is, however, unlikely to be of major importance in, for instance, preventing access to machinery for maintenance purposes, since in most cases the equipment itself will be more radioactive than the lubricant.

Effect of Radiation on Lubricating Fluids.—In the absorption of high-energy radiation a cross-linking reaction usually occurs. Hydrogen gas is liberated with the temporary formation of free radicals, followed by the formation of larger molecules resulting in a more viscous product with eventual solidification. Unsaturated molecules are also formed which means that the product will also suffer a reduction in oxidation stability.

Irradiation experiments on hydrocarbon products confirm these points, as can be

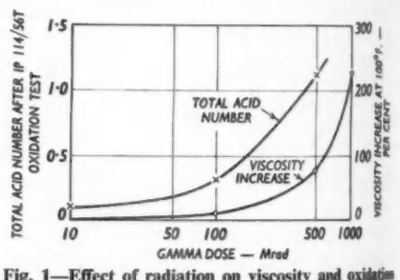


Fig. 1—Effect of radiation on viscosity and oxidation resistance of high quality inhibited hydrocarbon turbine oil

seen in the case of a conventional high-quality inhibited turbine oil (Fig. 1).

At the opposite extreme a cleavage reaction may occur, although there are conflicting thoughts here. A possible cleavage reaction might result in small molecules and some unsaturation, which means that a viscosity decrease could occur accompanied by reduced oxidation stability. However, it is generally considered that in most radiation-induced reactions on hydrocarbons both higher and lower viscosity products are formed but that the former usually predominate, although cleavage may be more noticeable in polymeric materials as will be observed later.

Experience has shown that certain compounds, notably those containing aromatic groupings, possess above average radiation resistance. These compounds are usually characterised by complex molecules which "resonate" between a number of possible electronic structures, and which possess a

* Mobil Oil Company, Ltd., Technical Services Department, Coryton, Stanford-le-Hope, Essex.

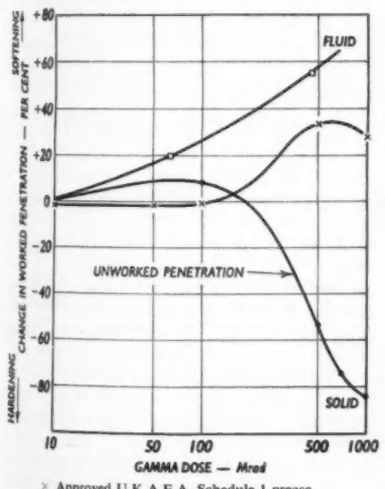
number of possible " excited " energy states, which are nevertheless fairly stable.

In a molecule such as a paraffinic hydrocarbon, the energy received from absorbed radiation may be sufficient to raise the molecule to an unstable state with higher energy than the electronic forces constituting the chemical bond, resulting in the possibility of bond fracture to give free radicals. On receipt of an equivalent amount of energy the aromatic molecule may also be raised to an excited state of higher potential energy, but it will be fairly stable owing to the greater electronic forces constituting its chemical bonds. The energy may be liberated subsequently, probably in the form of heat and light, when the molecule reverts to a lower energy state.

This ability of an aromatic molecule to absorb and then release energy without suffering appreciable degradation, has been loosely referred to as a " sponge " or " shock absorber " property.

Certain synthetic aromatics appear to be fairly stable to radiation, followed in decreasing order of stability by aromatic petroleum extracts, polyglycols, paraffinic hydrocarbons, diesters and silicones. The differentiation between the groups is not distinct however, and, for example, a selected silicone may be as stable to radiation as a paraffinic hydrocarbon. Also a lubricant can have its radiation-resistant properties improved by the addition of " anti-rads," whilst at the same time retaining its other desirable properties, such as temperature stability in the case of silicone fluids.

Effect of Radiation on Greases.—The damage caused by high-energy radiation on greases takes two forms, destruction of the thickener and degradation of the fluid. The former causes softening of the grease and the latter thickening and eventual solidification, and the precise pattern of consistency change is dependent on the relative radiation stability of the thickener and fluid.



× Approved U.K.A.E.A. Schedule 1 grease.
□ Grease with unstable thickener.
● Grease with unstable fluid.

Fig. 2—Different effects of radiation on consistency of various greases

Fig. 2 illustrates this showing penetration (consistency) changes for three greases. In one case the fluid has poor radiation resistance and the grease steadily thickens after a slight initial softening and eventually solidifies; the unworked penetration is shown for this grease in Fig. 2 because of its solidification. At the other extreme Fig. 2 shows the progressive softening which occurs with an unstable thickener resulting in fluidity of the grease.

An approved U.K.A.E.A. Schedule 1 type product is also shown in Fig. 2, illustrating satisfactory stability up to 1000 Mrad in so far as consistency is concerned.

The necessity for subjecting greases to a range of radiation doses is illustrated in the case of the grease having an unstable fluid (Fig. 2), since at a dose of approximately 170 Mrad there is no change in consistency compared with unirradiated grease. If tested at only 170 Mrad, this would suggest no change in the properties of the product, whereas in fact at this radiation level the slight softening shown at 100 Mrad (due to some thickener breakdown) has been offset by base fluid polymerisation, and it would require performance tests such as bearing rig tests to determine whether any degradation had occurred at 170 Mrad.

When studying Fig. 2 it should be remembered that all greases will eventually solidify at some critical radiation level owing to polymerisation of the base fluid, even if they become fluid initially.

It is also interesting to note that irradiation under static and dynamic conditions can produce different results, and in some instances static irradiation followed by dynamic testing has been more severe than testing under dynamic irradiation conditions. This aspect should not be overlooked, since there may be conditions in practice where lubricated components remain static for long periods.

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(*To be continued*)

New Lamps — or Old?

During the annual conference of the Association of Public Lighting Engineers at Scarborough last week, four papers were presented on the general theme of " Colour, Efficiency and Economics." We abstract below some passages from the paper, " New Lamps—or Old," by Mr. H. Hewitt, M.I.E.E., F.I.E.S., in which he surveyed the newer sources now emerging for streetlighting and floodlighting.

THERE are two fluorescent tube developments that might be considered as advantages in street lighting. We have recently seen the emergence of the " high loaded tube," though as yet there have been difficulties in regard to lumen maintenance and also in regard to life. If, however, one takes the present 5ft 125W high loaded tube and assumes that it could eventually achieve a 5000 hour life, a combination of three of these tubes in one lantern would still not appear to be a good proposition economically; nor is it thought that the higher brightness of the source would be of any great advantage to the lantern designer in controlling and distributing the light. It would seem, therefore, that the only possible field for the high-loaded tube out-of-doors is in floodlighting applications, and this will be referred to later.

The other possibility, however, is that a higher efficiency from the fluorescent tube may be gained at the expense of colour-rendering. The idea of applying such a tube to street lighting is not new, for it was mentioned by Jackson, Molloy and Scott in 1956[1]. At that time it was pointed out that if one was prepared to accept a green fluorescent tube there would be an obvious gain in efficiency. The green tube itself is not likely to be tolerated, but would a " greenish " tube meet with acceptance for main road lighting if, because of higher efficiency, it could be shown to be an economic proposition? Perhaps people who have learned to accept the colour distortion of monochromatic sodium lighting would be prepared to accept a different though less violent form of colour distortion. So far as side street lighting is concerned it seems to me that there is no need to " go green." The orthodox colours of fluorescent tube are a good proposition particularly if the lantern designers can rise to the challenge.

And now, back again to incandescence; for there is at the moment a great deal of interest in the quartz iodine lamp in which iodine is used in a regenerative process to deposit evaporated tungsten back again on to the filament, improving both the life and lumen maintenance of the source. Because of the nature of its operation the filament must be contained in a quartz tube, and all operating difficulties have not yet been overcome. Nevertheless, it is at this stage that we should ask ourselves whether the quartz iodine lamp may have some applications in street lighting.

Considering main roads first, if one was to assume that a 500W mains voltage lamp had an efficiency of 25 lumens per watt and a life of 2000 hours, and an attempt was made to fit this source into, say, Lamp Category 3 [lamps providing from 7000 to 15,000 lumens per point], I think it would be found that the economics were hopeless—for here the quartz iodine lamp would be trying to compete with high efficiency sources. If, however, one postulates a 100W lamp of similar characteristics and compares this with the sources included in Lamp Category 1 [lamps providing up to about 3500 lumens per point], then I think it will be found that a feasible case can be made; and perhaps such a small source would stir the lantern designer to new ideas.

It has also been suggested[2] that the quartz iodine lamp be used as a ballast for the mercury vapour lamp to form a new type of " mercury tungsten " lamp of good colour qualities and good life. This is an interesting idea which is being pursued at the present time, but it is difficult to make out a good case for such a lamp on economic grounds unless it was relatively low in price—and this seems unlikely.

We must also look at the large-scale lighting job which can best be performed by a source of extremely high output, and it is interesting to speculate on the future of

the xenon arc which has already been applied on the Continent, chiefly for the lighting of public squares, &c. Although the luminous efficiency of the xenon arc is not very high, it gives light of excellent colour quality. It has the disadvantage, however, of requiring bulky and expensive control gear and its use is likely to be restricted to those situations where a great deal of light is required from very few sources.

Since we are concerned in this paper with all lamps used out-of-doors we must look at the requirements of floodlighting. Much of what I have already said applies to a considerable extent to what may be described as "area" floodlighting, e.g. the lighting of works areas, playgrounds, &c. It is only when there are special requirements in lighting of this nature that these general economic principles fail to apply; for instance, in the lighting of football grounds where there are very short operating hours and where a high degree of control in light distribution is necessary. In decorative floodlighting, however, the requirements are different; for in this field, whilst lamps must be reasonably efficient, it is perhaps more important that they should lend themselves to good control (both optical and electrical) and be capable also of producing colour effects.

It would perhaps be appropriate to look at two broad groups of lamps. Firstly, those lamps which are normally used at a distance from the subject, where ease of optical control is perhaps the greatest necessity. Secondly, there are those lamps which are more advantageously used for localised lighting when more remote positioning is not possible. Here the large area, low brightness source is of great use.

Looking first at the lamps used from a distance, we must first note the wide acceptance of the normal incandescent lamp, particularly in the higher wattage ratings, and including the tubular "horizon" lamp. The interesting development in recent years, however, has been the use of reflectorised incandescent lamps in which at least part of the optical system is in-built within the source itself. One interesting example is the 24V 150W crown silvered lamp which, when used with a suitable reflector produces a very narrow beam with a peak intensity of nearly 500,000 candelas. This unit has been used successfully for the lighting of small details at great distances, e.g. the towers of the Royal Naval College, Greenwich, and the cross and orb surmounting Big Ben. Another example of reflectorised lamp is the mains voltage 3000W half-silvered lamp used in association with the "Infranor" principle where planar mirrors collect the light from the lamp and produce an exactly rectangular beam of various dimensions.

I have already referred to the possible use of the quartz iodine lamp in street lighting, and it is equally true that this source could find application in floodlighting, where the high brightness and small size lend themselves to good optical control in the projecting unit. An early experiment has recently been carried out with one of these lamps in a "baby mirror spot" for floodlighting the facade of Greys Court, Henley-on-Thames, with a single 500W lamp. The lamp has been used in America for more utilitarian forms of floodlighting, and it will be interesting to see what further developments take place in this country.

The sodium vapour lamp can be used most successfully in decorative floodlighting, not primarily because of its high efficiency but because of its colour which, though not so welcome in street lighting, can be most effective in the lighting of stonework. The mercury vapour lamp, too, has its place; in fact, perhaps the only field in which the uncorrected mercury lamp still has an obvious application is in decorative floodlighting where its colour can be attractive. Unfortunately, however, neither the sodium nor the mercury lamp lends itself to dimming, and this limits their use for certain outdoor applications.

When we turn to the use of more localised sources we recognise at once the important part that can be played in decorative floodlighting by the various colours of fluorescent tube. As a low brightness source of large area the tube can be positioned close to a building without producing "hot spots," and when two or more tubes are combined in one fitting a whole variety of colour effects can be obtained. These effects are, of course, produced by an additive process, and, therefore, produced more efficiently than by the subtractive process of using incandescent lamps with coloured filters or coloured reflectors. The high-loaded tube, which may not have street lighting applications, has been used effectively in localised floodlighting where the extra "lumens per foot" of tube can sometimes be of advantage.

An interesting new development from the fluorescent tube is the "aperture tube" in which a reflector coat is introduced between the phosphor and the tube itself and a narrow "window" is left clear, constituting a line of very high brightness approaching 25,000ft-Lamberts [with this tube a special reflector fitting can produce a flat beam of light of high intensity]. This is a development which has a number of utilitarian applications, e.g. "balustrade" lighting for bridges, road sign lighting, &c., but it would lend itself also to decorative floodlighting where higher brightnesses must be provided from local sources and where good cut-off in one plane is essential.

Localised sources may even be integrated in the structure of a new building. An interesting example is Castrol House in London, where cold cathode tubing is used to light coloured panels beneath the windows. Where physical circumstances permit, the 8ft 85W hot cathode fluorescent tube is being considered for a similar purpose. Looking to the future, perhaps the electroluminescent panel will make our buildings almost self-luminous.

A more elaborate outdoor floodlighting installation, e.g., any "Son et Lumiere" performance, uses many types of lamps, incandescent being used remotely to project directional light at appropriate angles, with fluorescent tubes used locally to assist the general lighting and also to provide colour effects. It is possible to incorporate all these sources within one dimming system; it is here, however, that we see the difficulty of incorporating sodium and mercury lamps, for though their colour may be acceptable they do not lend themselves to dimming.

I started out to make a simple study of electric lamps: but no such study can be simple. It becomes more complicated as we demand more light and a wider variety of light sources. But we must try not to forget the old as we welcome the new. We should recognise, too, that many factors determine the correct choice of lamp, and that this choice is not easy for the street lighting engineer, whose decision irrevocably commits a large public expenditure for many years ahead.

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Training Centre at Cowley

The Pressed Steel Company has for many years operated comprehensive training schemes for employees and has, at any one time, up to a thousand people under one form of training or another. Training facilities within the organisation are being expanded, and a major step in this direction has been taken by the building of a large training centre at Cowley, Oxford.

PRESSED steel has four main manufacturing divisions; motor-car bodies, railway vehicles, refrigeration, and aircraft, and its principal factories are at Cowley, Swindon, Linwood (Paisley), Swansea, and Theale (Reading). Training facilities exist at all the company's factories. At Cowley, the first and still the largest of the company's plants, all the training and associated administrative offices are now housed in the new training centre, which was formally opened on September 20. This new centre serves not only to accommodate all the Cowley facilities, but also to act as a group centre for specialised training of staff from other factories in the group. Extensive accommodation is provided for training craft and student apprentices, graduates and secretarial staff, and for specialised courses giving training for management, supervisory and executive positions and foremanship. In addition, facilities are provided for special-release courses on industrial relations in engineering workshops or, briefly, trade union courses. These courses are conducted by the Delegacy in Extra-mural Studies of Oxford University, the company's part in them being confined to providing the accommodation and arranging for the release of employees during working hours. Training and instruction in all the other subjects are given by the company's own training staff.

Because of the extensive nature of the facilities provided, together with the considerable numbers of persons undergoing training, a large building was required. It has been erected, at a cost of £250,000, near the main office block, and is in two main sections, administrative and craft training. The building is entirely of reinforced concrete, the external faces having been treated to expose the aggregate and so give a textured finish. Acoustic tiles are fitted to all the ceilings, and the floors, in the main, are of reinforced concrete finished with thermoplastic tiles. In the craft school the floors are of end-grain hardwood blocks, and hardwood blocks are used in the gymnasium. Fluorescent lighting is installed throughout, and the heating, by accelerated low-pressure hot water, employs continuous "Vectair" radiators below the window sills. This makes it possible for the internal partitioning to be re-arranged at any time should it be necessary. The administrative section has five floors and the craft school six, but in both cases open planning has been adopted.

New block seen from the road : (right) administrative ; (left) craft training

as far as possible at ground level, to maintain access to a car park at the rear.

The five-storey administrative block is 110ft long and 35ft wide, with an entrance hall on the ground floor. It can also be entered through the main hall, partly beneath the two blocks. On the first floor are offices for supervisors and general administration personnel, while the second floor houses lecture and typing class rooms, a conference room, projection rooms and a work study laboratory. A drawing-office, lecture room and library are the principal features of the third floor, and a second, larger, drawing-office occupies the major part of the fourth floor, where the group personnel director's office and a syndicate room are also situated.

Craft Training School

Adjoining the administrative block and communicating with it by means of through corridors at the rear on each floor is the craft training school, where practical instruction is given in a variety of trades. On the first floor are a large gymnasium, a machine shop and a welding shop. In the machine shop all the normal basic types of machine tools are represented. They can be divided into four main groups ; lathes, horizontal and vertical millers, grinders and shapers. Basic machining skills are taught here, and there are no special-purpose machine tools. Acquaintance with machines of this type comes later in an apprentice's training, when he works in the production shops. In the welding shop two lines of welding booths are provided to give facilities for learning the skills involved in gas and electric welding and also in resistance welding, which is so important a feature in the company's production work.

On the second floor of the craft block the main rooms are those devoted to practical instruction in pattern making, sheet metal working and fitting. The company has no foundry at Cowley, but makes its own patterns for press tool castings, and the equipment in the training pattern shop is similar to that used in the works pattern shop. It includes dimension and band saws, sanders, planing machines, measuring equipment, tables and all the normal hand tools. In addition to engineering pattern-making, the production of wooden "mock-ups" for new types of car body is taught in this shop. Sheet metal working is taught in the adjoining shop, where the emphasis, again, is on basic processes and skills. Consequently, the equipment is all of a general type. It includes benches, guillotines, shears, roll-forming machines, wheeling and raising machines and simple drilling machines. Engineering fitting is also taught in the same way in the last of the three main shops on this floor. Here the main items of equipment are benches and vices, hand tools, pedestal grinders and a drilling machine, together with a surface table and a comprehensive set of measuring and marking-out tools.

Integration with External Training

Within this single building at Cowley are facilities for every type of training necessary for the efficient staffing and manning of the company's works, from instruction in basic engineering skills for boys straight from school to the running of courses for higher management positions. There is ample space, and all the equipment is new and of modern design. It is stressed, however, that the facilities provided at Cowley do not conflict with those provided by technical colleges and universities ; rather are they complementary to them. In the many different courses run by the company provision is made for students to take part in schemes organised by outside educational authorities. Indeed, attendance at organised day or evening classes is compulsory in some types of training, and arrangements are made for release of selected students who could profit by taking part in higher educational schemes.

Part of the craft training machine shop

Working model of press shop in which simulated production problems can be set for training purposes

Historical Notes on Piling

On Thursday, October 6, the Institution of Structural Engineers' new president, Mr. F. R. Bullen, delivered his address, which he called "Notes on the History of Foundation Engineering." He took the Institution's motto Fundamento Semper Stabili (" *Always on a Sure Foundation* ") *as an excuse for this subject, and pointed out that the subject was largely bound up with the equipment available for carrying out the work. From this address, which is of exceptional interest and erudition, we have selected the following abstract on piling.*

THE primary purpose of piles in early times was to compact or consolidate the ground ; the idea of using piles solely for bearing vertical loads appears not to have occurred to the architects and engineers of those days. Indeed, when Edward Cresy wrote his encyclopaedia in 1861 he stated somewhat categorically that the object of pile driving was to consolidate the ground : he added, however, " that piles are also resorted to when a solid stratum lies at a depth too great to uncover or when it is crossed by layers of soft earth difficult to remove." He advised : " that bearing piles should be loaded with a weight equal to the load to be carried and that such weight should be left on a sufficient length of time to remove any doubts upon the subject." "The only means of judging correctly," wrote Cresy, " the resistance of a pile is to examine the nature of the stratum on which it bears, the hold which it takes and whether it has penetrated a solid not susceptible of yielding under the weight of the construction such as rock or gravel, provided this latter cannot be washed away with the current. The refusal of a pile to advance does not always ensure its having arrived at a proper bed, the nature and consistency of which should always be previously ascertained."

Many instances could be adduced where piles have sunk under the weight placed upon them for want of these considerations. For the piled foundations of bridges, Alberti specified a width of piling equal to twice the width of the wall carried. The length of the piles should not be less than one-eighth of the height of the wall to be carried and their diameter not less than one-twelfth of their length. Jean Rudolphe Perronet (1708–94) thought that 12in piles should not be loaded with more than 50 tons and 9in diameter piles with more than 25 tons.

Perronet further suggested that piles should be driven until the penetration, during the last " heat " of twenty-five to thirty blows, did not exceed 1–2 " Paris lines " (1 line=$^1/_{12}$in) or six lines in the case of less loaded piles. " The driving force " of the rammer," he said, " is proportional to the height of its fall," but, he goes on " On n'ignore pas combien il est difficile .... d'établir mathématiquement aucun rapport entre les forces mortes (static forces) et les forces vives (dynamic forces)." The essential features of Perronet's pile engine were the leaders, the hammer and the multi-tailed rope. It was known as a Ringing Engine. When the ram or monkey had been hauled to an appropriate height it was released by " nippers," a device like a pair of tongs which opened at the lower end by having the upper ends closed together. Perronet used his engine in many forms, including one driven by horse-power and one on a floating craft and operated by an armed wheel.

Another famous piling engineer was Louis Alexandre De Cessart (1719–1806). For the foundation of the bridge at Saumur in 1756, De Cessart used a 10in diameter axis with hand wheel 12ft diameter ; eight men turned the wheel and raised at three turns a ram weighing 1500 lb 6ft high. To regulate the height of fall and the price of driving, it was determined that it should be limited to a stroke of 8ft to 10ft ; the price was 20s. per pile including transport ; the scaffold piles cost 10s. each. In all these machines, however, the hammer weights were not generally greater than 1 ton and usually much less. By 1861 it seems that De Cessart had also invented a machine for withdrawing piles and one for cutting the heads under water. By 1861 a steam pile driver also had been invented and was in use in America. A steam hammer evolved from an idea of James Nasmyth (1808–90) was used for pile driving at Devonport in 1845.

It may be of interest to record that when in 1902 the piles under the Campanile of St. Marks, Venice, were examined, although they were 1000 years old they were found to be good enough to support the new building. And in 1919 the rock elm piles used under the Newcastle High Level Bridge and driven in 1846 were still in good condition.

The technique of using a " jumper " for cutting through a hard layer seems to have been well known by 1861. Cresy says that holes may be pierced with an iron-shod piece of timber or rod of iron working perpendicularly through a frame or hole out in a large stone.

The method of driving piles with the aid of a water jet was used for driving the piles to support the scaffolding for the Severn Railway Bridge in 1875 and was attributed to Sir James Brunlees (1816–92) who had used a similar technique at the Kent and Leven Viaduct in 1856–57. This device was of especial value in the Severn valley where the bed of the river consisted of " 28ft of tenacious sand " overlying the old red sandstone. There is also a reference to jetting having been used at Friatagorda Bay in 1852, the idea of Geo. D. McClellan of U.S.A. Corps of Engineers.

The use of long piles under buildings particularly seems to have developed, at least in Chicago, in the years 1883–90. Their introduction however gave rise to much litigation on account of the effects of the pile-driving on nearby structures. At that time cast-iron caps were used on the piles and drop hammers were 2800 lb, 3200 lb or 3800 lb weight each. The height of fall was as much as 35ft to 40ft and the movement of the pile was of the order of 3in per blow. It is recorded that during the driving of piles at the Illinois Central Station, some piles already driven were observed to rise 4in. In 1893 an improved technique of pile-driving was used on the foundations of the Chicago Public Library ; a Vulcan steam hammer with a weight of 4500 lb and a drop of 42in working at fifty-four blows per minute was employed. A set of forty-eight to sixty-four blows per foot for a normal pile or twenty-four to thirty-two blows per foot if a " follower " or " dolly " were used was specified. The design load was 30 tons per pile and a group of four piles was tested to a load of 50·7 tons per pile.

At this time there seems to have been little known about calculating the bearing capacity of a pile. About 1820 A. J. Weisbach (1806–71) published a formula based on alleged fundamental energy considerations which also included a term to account for the elasticity of the hammer ; in 1851 the Journal of the Franklin Institute contained a formula put forward by a Major John Sanders of the United States Corps of Engineers for timber piles driven into river mud. It took the form

$$R=\frac{WH}{8S}$$

R being the safe resistance ; this formula is interesting in view of Perronet's opinion some seventy-five years earlier that the driving force is proportional to the height of fall of the hammer. In 1862 W. J. M. Rankine (1820–72) published his formula which seems to have been based upon the theory of elastic impact developed by a Dr. Whewell (1794–1866) in 1841. Its form is complex and was simplified in 1929 by Mr. G. B. R. Pimm (past president).

Pimm's form of the Rankine formula is comparable to the formula published in 1888 by A. M. Wellington (1847–95) in America and often known as the " Engineering News " Formula. It is used with a factor of safety of six on the assumption that no pre-exploration of the sub-strata has been made, i.e. no site investigation has taken place. The values assigned to the constant it contains are as varied as their authors ; accordingly for any particular site a calibration may be carried out to fix the particular value. If account be taken of the effect at impact of the relative weight of the pile and the hammer, then the Wellington formula assumes the form of the Dutch formula often used with a factor of safety of six.

There are other similar variations and it might not be an unfair comment to say that the variations depend largely upon the authors' personal views of the relative importance of the terms they include or reject. Eytelwein (1764–1848) gave a form almost identical with the Weisbach-Dutch form.

It thus seems that form the middle of the nineteenth century much activity occurred in an attempt to evaluate a fair relationship between the bearing capacity of a pile and the measurements which may be taken during the final stages of driving. Since those days there have been further attempts of a somewhat " hit-and-miss " character and it was not until 1925 that a serious attempt was made to put the matter upon a reasonable basis. In that year there appeared in *Engineering* a rational pile driving formula published under the name of A. Hiley which claimed to be applicable to most ordinary methods of driving piles. Hiley's final conclusions appeared in *The Structural Engineer* in 1930 ; a factor of safety of three or four was recommended. The derivation was from the original basic considerations which had produced the Weisbach, Wellington, and other similar formulae so that its value consisted largely of the tables published by its author and assembled from a wide range of piling practice. The Hiley formula has enjoyed wide popularity, particularly in this country ; the Wellington formula has continued to be used abroad, particularly in America. Nothing should be said to minimise the value of Mr. Hiley's contribution to the subject of piling formulae for it is fair to say that with the advent of his formula, most other formulae went out of use, and much loose thinking was eliminated.

Nevertheless, it has some limitations. For

example, the calculated resistance to driving for a particular pile varies widely according to the weight of the hammer used or the hammer drop allowed ; it also seems to exaggerate the importance of the weight of the pile. Consequently, there appeared in 1947 under the name of Dr. Oscar Faber (past president) a "New Piling Formula."

This formula might fairly be said to be "empirical" in nature. A certain factor p in the denominator was called by Dr. Faber, a plasticity factor ; when driving in non-cohesive or granular materials, $p=1$, but when the toe of the pile rests in a substantially cohesive material, the resistance to driving was found by Dr. Faber to be greater at the time of driving than some hour after. On the other hand, for driving in cohesive material, Dr. Faber added a quantity to account for the "take-up" which occurs with time. Thus 1947 saw built into a dynamic formula for the first time two important factors, namely, the plastic or viscous property of the ground at the toe and the adhesive or frictional property of the ground surrounding the pile.

Dr. Faber's formula has not received the recognition which it deserves, for in my view it represents an advance on Hiley's formula. On the other hand, I have found cause to criticise it and ventured, therefore, in 1959 to suggest another method for calculating the bearing capacity of driven piles. Here the suggestion was made that the toe support and the side support can be separately calculated whether the pile is in cohesive or granular material and added to give the total support. The toe value is based upon the mathematical work of Isaacs and Fox first published in 1932, which considered the force at the toe of the pile as set up by a longitudinal wave motion passing down the pile. The form of the relationship is simply

$$T=R+F$$

where R is the bearing capacity at the toe and F is the value of the friction on the walls of the pile. The value of R is subject to a plasticity factor when the toe is driven into a plastic material and the value of F can be positive or negative according to whether the friction supports or "drags down" the pile. Whilst it would be immodest to claim much for this latest effort the writer has found it to give results which account for much of the "scatter" usually associated with such calculations. It might be emphasised also that this value of R is the resistance to penetration under a static load and not the resistance to driving as previous formulae have given.

It is of interest, therefore, to reflect that although the technique of driving piles into the ground has been used, if not understood, for perhaps, 2000 years, it is only in the last 100 years or so that a quantitative approach has been made. There are those to-day who say that a dynamic approach should not be made ; rather, they assert, a static calculation is the more reliable, depending as it does upon the properties of the ground and not upon the technique by which the pile is placed therein. Perhaps, after all, Sir Benjamin Baker was not so far wrong when he said : "by no amount of sticking in of pins could it reasonably be expected to consolidate a pat of butter."

A. C. Dean suggested, even in 1935, that remoulding of the clay occurs when piles are driven into it. And in 1856 Cresy wrote : "in clay, naturally firm, the pile sometimes becomes a conductor to the water which insinuates itself along the sides, softening and producing a settling, which would not have taken place had piling not been introduced." It remains a fact, however, that some satisfaction is obtained when it is known that the "driving is hard," so that there must be some merit in endeavouring to compute the value of the "hard." This endeavour is illustrated by the fact that one book enumerates about thirty-three dynamic formulae as well as eight static and six empirical.

Types of in-situ Piling

Until the end of the nineteenth century, most piles seem to have been made of timber. Precast reinforced concrete bearing piles were introduced by Edmund Coignet (1850–1915) in 1894 and by Francois Hennébique (1843–1921) in 1897. Reinforced concrete sheet piles were used in Morocco in 1916–18 and in this country at Wisbech in 1929, and at Stratford, London, in 1928–29. In contrast to timber or precast piles, there have been developed those piles which are placed in the ground rather than driven in. There are, however, certain intermediate forms of piling in which a tube is first driven into the ground by one method or another, and later filled with sand or concrete. For example, the earliest of these appear to have been :

Sand Piles.—The use of sand piles for foundation support in poor ground was common from about 1830–50. Structures in Bayonne and elsewhere on well rammed sand piles are referred to. Gauzence is credited as requiring the sand filling to be moistened and rammed "until his walking stick could not be pushed in."

The Raymond Pile.—The original pile was continuously tapered and was used in America about 1897. The maximum length used was under 40ft. It was subsequently introduced into this country in about 1931 and then gave place to the step-tapered pile which can be driven in lengths up to 80ft.

Simplex Piles.—These were brought into this country in 1905 from America where they had been in use for some years. They were introduced here by H. P. Lancaster, a founder member of this Institution ; the first contract was in 1906 at Birkenhead.

The Franki Pile.—This system of piling was invented by Mr. Edgard Frankignoul in 1909 ; the first trials were made in Liège in 1909 and the first foundations built were for the new offices of the Division Calcinage de la Société Anonyme John Cockerill. In 1925 the then four varieties of piles were replaced by the present method of driving a concrete plug within a steel tube and this method has been used all over the world. The standard hammer weighs about 2 tons and the tube varies in diameter from 14½in to 24in.

Vibro.—This system was first used in 1920 or thereabouts and consists essentially of vibrating wet concrete into a hole formed by a steel tube. It was invented by Mr. A. Hiley and described by him in March, 1927 ; 689 such piles were used for the rebuilding of St. James Park Station.

Prestcore.—This system was first used in 1930 or thereabouts and was introduced to overcome the danger inherent in placing wet concrete into water-laden ground. Short lengths of precast concrete are threaded into a tube and later grouted solid as the tube is withdrawn.

West's.—Shell pile was developed in several stages between 1923 and 1934 by Mr. Alexander Rotinoff, a Russian engineer of British nationality ; the first shell piles were driven in 1929. In 1934 the patent rights were taken over by the present company and the form modified to that which is used to-day. It consists of precast concrete tube shells threaded on to a steel mandrel assembled on a concrete shoe. The whole unit is driven into the ground although the greater proportion of the hammer blow is applied to the mandrel and thus to the toe. The mandrel is then withdrawn leaving the hollow pile in the ground, and this is filled with concrete and a reinforcement cage as necessary.

The Holmpress Pile.—This was introduced some twenty-five years ago ; it consists essentially of a steel shell driven into the ground which is later filled with concrete. The outer tube is withdrawn at the same time as the wet concrete inside is driven into the ground by another hammer of smaller diameter. This form was introduced as being preferable to a simple bored pile with expanded base which had been used by the same firm for some few years previously (*c.* 1930).

All these forms and a number of others of recent introduction are driven in some measure first and then cast *in-situ*. To-day there are those forms of piles in which no driving occurs, but in which a hole is bored or augered in the ground, and the hole is subsequently filled with concrete. The earliest of these seems to have been :

The Smith's Pile.—The first bored piles were put down in August, 1919, in interesting circumstances. The firm, an old-established company of well drilling contractors, were approached in 1919 by a Grimsby architect, Mr. Walsh, who was faced with a foundation problem when building a new cinema. It was not possible to drive piles owing to the effects on adjoining buildings and Smith's were asked if they could bore holes down to boulder clay, put in a cage of reinforcement and fill with concrete. Thus the first fifty 12in diameter bored piles were installed and the load-carrying capacity was assessed as 20 tons per pile. The Expanded Pile Company, Ltd., was formed in 1947. A belling tool for under-cutting the bases in cohesive soils was patented in 1935. In 1957 the firm constructed their first large diameter rotary bored piles, eighty 36in diameter 70ft deep with mechanically cut bases 7ft 6in diameter.

Pressure Piles.—These were evolved first in Germany in early 1920 from standard well-boring equipment, and were introduced into this country in 1928 by Mr. J. F. Barr. The first piles used were in the foundations of the Custom House at Belfast and the Playhouse, Edinburgh. One of the original features of this pile was the provision of an air-lock on the tube to facilitate placing the concrete when the tube and ground were waterlogged. To-day this is little used, other methods being employed to combat the effects of water.

These and many other bored piles are now available, in varying diameters suited to the ground condition.

The Bearing Value of in-situ Piles

In a treatise on civil engineering in 1895, W. R. Patton stated that:

$$T=AB+SF$$

for buried piers and gave, in tabular form, values for B and F according to ground conditions. Patton applied Rankine's theory of earth pressure making use of various measured values of ϕ (the angle of internal friction in a granular material) and μ (the coefficient of friction between various materials). Bénabencq in 1911 gave a carefully detailed formula making due acknowledgment to the works of Rankine, Falmant and Résal. 1922 saw the Dorr formula, 1927 the Vierendeel formula and in 1932 an essentially empirical formula by Wilcoxen based on model tests. A distinct advance was made in 1954 when Golder and Leonard published the results of some researches on

piles bored into London clay. These gave results equivalent to :

$$T=R+F$$

where :

$$R=9 \cdot c_p \cdot A$$

and

$$F=0{\cdot}7c_a \cdot 1{\cdot}4\text{d}.$$

where c_p=the cohesion of the clay at the toe of the pile and c_a=the average cohesion along the embedded length.

This result seemed to confirm the theoretical researches of G. G. Meyerhof, who in 1952 had published a modification of Terzaghi's work on the bearing capacity of foundations. More recently still, in 1959, Professor A. W. Skempton, F.R.S., has suggested that the factor 0·7 ought to be between 0·3 and 0·6, say 0·45 with a limiting value of 2000 lb per square foot in London clay (also suggested earlier by Meyerhof). One of the most important factors in these calculations is the value of the cohesion of the clay which is usually measured in a Triaxial machine on an " undisturbed " sample. The term appears, however, to be somewhat relative, since Ward and others have shown that the values of the cohesion measured on hand-cut samples taken from excavations (in tunnel) are often nearly twice those obtained by normal sampling methods. This may account for the differences between Skempton's coefficients and those put forward by Golder and Leonard. The present author's experience tends to suggest that the coefficient

$$N_c=9$$

at the toe seems to rise to perhaps 12 and the adhesion coefficient to fall more nearly to 0·3. Once again, the differences may be due to the measured values of the cohesion depending upon the tests used and the method of preparation of the samples. On some tests carried out at Audley Square, London, W.1, on bored piles 24in diameter, 110ft long, there is little doubt that the coefficients were nearer 12 and 0·2 respectively.

Other Types of Piling

Recent years have seen the introduction of the modern cylinder or caisson pile, with or without an enlarged base. In 1924 Mr. Rotinoff obtained a German patent for what he called " a sectional caisson pile " of 1m diameter and in 1930 this form was introduced. About twenty years ago a technique was introduced by Benoto for sinking cylinders 1m diameter by the combined operation of grabbing inside and oscillating outside a cylinder placed in the ground. This process in a variety of forms is operated to-day by a number of British contractors and constitutes an efficient means of excavating to considerable depths, 100ft and more, to construct a vertical cylinder of concrete. A development of this has been introduced from America (the Chicago caisson pile which was really a well and was under-reamed by hand was introduced in 1894) for piles in clays whereby the excavation is removed by an augering process, and in which it is possible at a specified depth to " under-ream " to produce an enlarged base. Such an arrangement has enabled very large loads to be carried on single columns in cohesive ground although it is by no means certain that the settlements attending such high concentrations of load are properly understood. Whilst it might be considered a cynicism to remark that such piles have been as instrumental in promoting argument as in solving foundation problems, it is true that the relative amounts of support achieved by the toe and the sides of the pile are constantly under discussion and many rather " immature " statements have been made from time to time. The matter is the subject of much research at the present time ; contractors have been able to find common ground and working with consulting engineers have set up a research committee to carry out a number of full scale tests. In the past, little recognition has been given to the supporting values of the friction on the sides, but there seems to be developing a view that the skin friction is more important than the toe resistance. The forerunner of these cylindrical supports was clearly the caisson foundation used and described by Vitruvius 2000 years ago.

One of the most recent foundation techniques to be introduced is called Vibroflotation. It is a technique applied to fine sandy material of low density whereby the material is subjected to vibration to increase the density and thus the bearing capacity. It has been used in America, West Africa and north-west England and is at present being applied on the north-east coast.

An outstanding development in the driving of preformed piles is the Diesel hammer, a machine produced in Germany and capable of revolutionising pile driving. The driving characteristics of this equipment are such that the blow is fully transmitted to the pile and the piles moves so smoothly that similar piles have recently been driven alongside a brickwork wall supported on strip footings at ground level. A warning should be sounded as to the output of energy per blow : according to detailed measurements I have made, the published energy figures are realised only when driving is hard enough to cause the piston to rise to its full height. When the driving is softer, the piston does not rise high enough to allow the hammer to deliver a full blow, and under such conditions it is necessary to adjust the calculations. It has been found possible, however, to apply my new calculations to this form of hammer.

Screw piles were invented by Mr. Alexander Mitchell (1807–48) and were widely used by him and others for the foundations of lighthouses, beacons, piers, jetties and breakwaters in situations where soil was composed of loose and unstable sand, or when the waves might undermine the work. In 1851 at the Goodwin sands, a hollow pile, 6in diameter, was screwed down easily to more than 50ft through fine and compact sand. It seems that about that time no device was as successful as inserting into the sand a bar of iron having at its lower end a broad plate or disc of metal, either of spiral or helical form, like a screw. The area of the plate was determined upon after the stratum it was to enter had been examined by boring : in a few cases, a diameter of 4ft was used. To-day screw piles in various forms are available, some in metal, some in reinforced concrete ; and piles with more than one blade have been introduced in recent years where the ground conditions have been particularly soft.

A brief reference to sheet piling may be appropriate. Telford conceded to Thomas Farnolls Pitchard the credit for introducing cast-iron into bridge construction about 1775. The first use of cast-iron for sheet piling appears to have been in the early nineteenth century at Bridlington Harbour. In 1822, a patent was taken out by Peter Ewart (1767–1842) a pupil of Rennie and in 1832 a patent using wrought iron was claimed. Cast-iron sheet piles were used at Brunswick Wharf, East India Docks in 1834. At the end of the nineteenth century, Larssen, in 1897, used steel piles at Bremen. To-day there are many varieties. One of the earliest uses of the " Universal " section was to form the cofferdams at the Western Entrance of the Royal Albert Docks, London, in 1932, when the entrance gates and locks were being reconstructed.

Preparation of Basic Slag Fertiliser

Basic slag has long been used as an agricultural fertiliser. New steel manufacturing processes are, in certain cases, having a beneficial effect on the nature of the slag, and a new slag processing works has been built at Scunthorpe to deal with the slag from the first British Rotor steel plant.

FOR a long time after Thomas and Gilchrist introduced their basic steelmaking process in 1876 there was little or no use for the by-product slag. This slag has a high phosphorus content, and as the result of the work of more than one investigator, but particularly that of S. G. Thomas, the joint inventor of the basic process, the value of the slag as a fertiliser was recognised, and by about 1890 very large quantities were being used. To-day, basic slag, the only indigenous British source of phosphoric fertiliser, is consumed at an annual rate of about 800,000 tons. The value of the slag,

Slag feed at primary magnetic separators

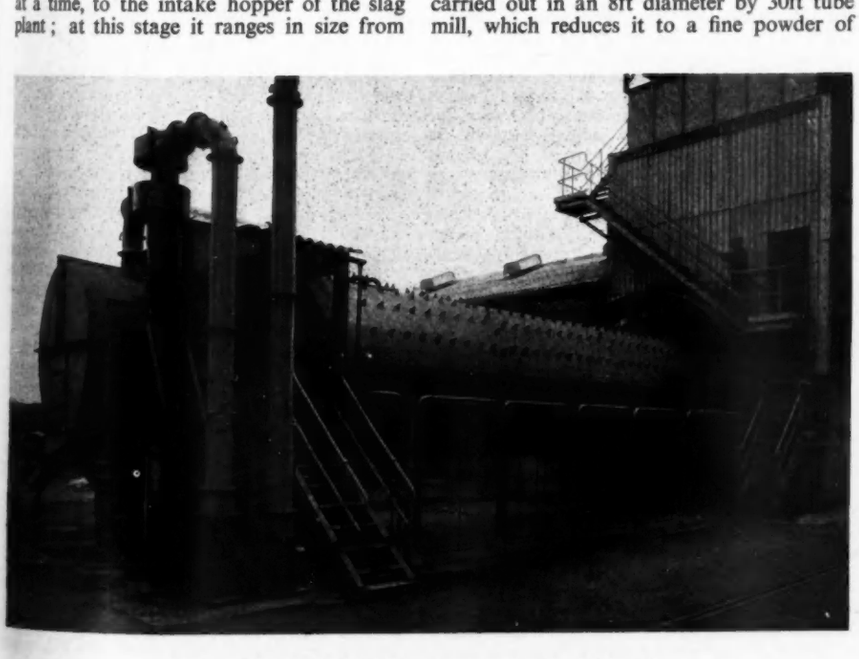
General view of Redbourn works

however, varies according to the metallurgical features of the particular steelmaking process, for steel is the primary product and slag a by-product. At the Redbourn, Scunthorpe, Lincs., works of Richard Thomas and Baldwins, Ltd., the introduction of the first British Rotor oxygen steelmaking plant has improved the quality of the slag from an agricultural point of view, and Scottish Agricultural Industries, Ltd., has built a new processing plant to deal with the slag.

Built at a cost of over £500,000 on a 3·2 acre site to the east of Redbourn Steelworks, the slag plant is designed to produce 120,000 tons of basic slag fertiliser a year. Near-molten slag from the Rotor plant is dumped from rail ladles on a bank running practically the whole length of the slag works site. Here it cools and weathers for a time, and it is then dug out by a diesel-driven excavator and laid aside for further cooling. It is then taken by mechanical shovel, 2½ tons at a time, to the intake hopper of the slag plant; at this stage it ranges in size from hard lumps as large as 8in down to dust.

An inclined plate conveyor takes the "as-dug" slag, at a rate of 50 tons per hour, to the primary magnetic separator, which consists of two 5ft diameter electro-magnets suspended over the conveyor. These magnets are automatically lifted clear of the conveyor in turn, traversed laterally to a chute and temporarily switched off, so discharging any ferrous metal they have collected into rail wagons for return to the steelworks. The slag then passes to a gyratory crusher, where it is reduced to 1¼in cube. After elevating and screening, the product is given a second magnetic separation treatment, a high-intensity drum magnet removing any small pieces of steel released by the crushing process. The crushed slag then passes to a 100-ton storage hopper, preparatory to grinding, which is the final processing needed to fit it for the market.

Grinding of the hard, abrasive material is carried out in an 8ft diameter by 30ft tube mill, which reduces it to a fine powder of which at least 80 per cent will pass through a 100-mesh sieve. The mill, which is driven by a 750 h.p. motor, is divided into three compartments, each charged with 16 tons of steel balls, 3in, 2in and 1¼in diameter respectively. A vibratory feeder loads the slag into the ball mill. Both crushing and grinding are done dry, and a large wet-type dust collector deals with the considerable amount of dust arising from these operations. Although the slag, after grinding, is ready for use as a fertiliser, it has to undergo physical and chemical checks before passing to the bagging and despatch points, and for this purpose it is elevated to one of four sampling hoppers, each of 300 tons capacity, where it is held while samples are analysed and graded in the works laboratory. After testing, the slag is elevated to any one of three concrete silos, each 67ft high and 26ft diameter, and each capable of holding 1300 tons.



Tube mill for final grinding to 80 per cent minus 100 mesh

Bagging and Despatch

Ground slag is taken from the storage silos to the adjacent bagging and despatch building by elevator and air-slide conveyor. Here it is held in despatch hoppers for bulk loading by swinging spouts into road or rail vehicles, or for bagging as required. For bagging there are two four-spout packing machines, each capable of filling 1 cwt. paper sacks at a maximum rate of 50 tons an hour. Filled sacks are discharged on to a belt conveyor and taken to loading points where they can be loaded directly into road or rail vehicles standing on weighbridges. Alternatively, the filled sacks can be conveyed to a palletising point, from which they are removed in 2-ton loads by fork-lift truck to an adjoining store. This can hold in stock some 9000 tons of bagged slag on pallets to deal with seasonal demands. Dust arising during bulk loading and bagging is dealt with by automatic dry dust collection equipment. The slag is distributed in England and Wales by Imperial Chemical Industries, Ltd., and in Scotland by Scottish Agricultural Industries, Ltd.

The principal contractors and equipment suppliers for the Scunthorpe plant were:

W. and T. Avery, Ltd., weighbridges; Joshua Bigwood and Son, Ltd., wet dust collecting equipment; Bone, Connell and Baxters, Ltd., structural steelwork; Bowater Packaging, Ltd., bag packing machines; Clugston Civil Engineering, Ltd., civil engineering work; Codd and Trafford, Ltd., office construction; Constantin (Engineers), Ltd., air-slide conveyors; Conveyancer Fork Lift Trucks, Ltd., fork lift trucks; English Electric Company, Ltd., electric motors and switch fuse gear; Franki Compressed Pile Company, Ltd., piling; Holst and Co., Ltd., concrete silos; M. and C. Switchgear, Ltd., l.t. switchgear and starters; Michigan (Great Britain), Ltd., loading shovel; New Conveyor Company, Ltd., ground slag handling plant; Ernest Newell and Co., Ltd., slag crushing and grinding plant; Bruce Peebles and Co., Ltd., electric motors and transformers; A. Reyrolle and Co., Ltd., h.t. switchgear; Ruston-Bucyrus, Ltd., excavator; James Scott and Co. (Electrical Engineers), Ltd., electrical installation; Visco Engineering Company, Ltd., dust collecting equipment.

Copper and Copper Alloy Extrusions. The Copper Development Association, 55, South Audley Street, London, W.1, has issued a booklet entitled "Extruded Copper and Copper Alloy Products," which gives general information on the manufacture, advantages and applications of these non-ferrous extrusions. Sections with re-entrant angles, which could not be rolled, can be extruded, but this is not the only advantage of this method of manufacture. Very often an assembly of several parts can be replaced by a single extruded section, with the metal ideally disposed for maximum strength, stiffness and economy. It is pointed out, too, that even when new dies have to be cut to produce a desired section, the quantities needed to make the job an economic proposition are not necessarily large. To these basic advantages of extrusion copper and copper alloys add some valuable properties of their own; they include high electrical and thermal conductivity, good corrosion resistance and mechanical properties, ease of machining and numerous other properties which are equally well known. Complex shapes, though certainly suitable for extrusion, are not the main product in terms of tonnage, of the process; the largest single outlet for extruded copper alloy products is free-cutting brass rod.

SHORTER REPORTS

Council of British Manufacturers of Petroleum Equipment

At the annual dinner of the Council of British Manufacturers of Petroleum Equipment, which was held on Wednesday, October 4, at Grosvenor House, London, and attended by about 1500 members and their guests, Mr. J. M. Storey, the chairman, gave the toast of "The Guests" and commented that the state of the industry was very much the same as last year. Industrial movement was closely governed by variation in the activities of the British, international and national oil companies, but there was a ray of hope for improvement, he said, to be found in a speech made recently by Lord Robens. In one statement he estimated that by 1970 the consumption of oil would increase from its present level of 35,000,000 to 70,000,000 tons of coal equivalent per annum. The chairman called the attention of the members to the annual meeting of the Federation of European Petroleum Equipment Manufacturers to be held in Marseilles at the end of this month. He stressed the importance of this meeting and mentioned that during it a series of visits would be made to important oil installations. Mr. Storey stated that the Council would be moving into new offices early in 1962 and that in June of that year would be held the Second Chemical and Petroleum Engineering Exhibition. During the course of the exhibition the Institute of Chemical Engineers and the Society of Chemical Industry will be holding a series of symposia, as part of the Third Congress of the European Federation of Chemical Engineering, to be followed by a symposium organised by the Imperial College of Science. In addition, he continued, the Federation of European Petroleum Equipment Manufacturers will be holding the Fourth European Congress at Church House, Westminster. Mr. Kenneth Horne replied on behalf of the guests.

Electricity Bulk Supply Tariff

Changes have been announced in the Central Electricity Generating Board's bulk supply tariff (for the year starting April 1, 1962) with the object of making its charges for electricity relate more closely to the costs of supplying loads of different characteristics. In particular, it is intended to encourage the off-peak use of electricity by offering a cheap night rate.

The 1962–63 tariff, which covers the Generating Board's bulk supplies of power to the twelve area electricity boards in England and Wales, consists of a fixed charge, based on the maximum demand for electricity, plus separate "day" and "night" running charges which are modified by a fuel price adjustment. Other changes in the tariff reflect the increasing importance of load factor. Reductions made in the running charges offset most of the increase in the fixed charge and the overall effect of the new tariff will be to increase the cost of electricity to the area boards by little more than ½ per cent. Details of the tariff are given below.

Unit Charge.—In the existing tariff the present basic price of fuel of 60s. per ton necessitates large fuel cost adjustments to meet the actual area price of fuel, which now averages 91s. per ton. The new tariff recognises this and raises the basic price to the more realistic figure of 85s. per ton. At this price the unit charge of the existing tariff would be 0·585d. per unit for all units. In the new tariff, however, the charge for "day" units will be marginally reduced to 0·58d. per unit, but the new charge for "night" units of 0·47d. will mean a reduction of nearly 20 per cent. The reduced rate will apply to units at night between the hours of 11 p.m. and 7 a.m. The fuel price adjustment rate is also reduced to follow the improvement in thermal efficiency, and the benefit of this change will be felt mainly in the high coal cost areas.

Kilowatt Charge.—The kilowatt charge is increased from £7 7s. to £8. This rise reflects the increasing burden of the C.E.G.B.'s capital costs and of the Board's policy of providing an increasing proportion of capital requirements from internal sources.

Another innovation is that the chargeable demand of each area board is based not on that board's own maximum demand, but on its demand at the time of the national simultaneous maximum demand. Area boards will thus have a more direct financial interest in the benefits resulting from limitation of the national simultaneous maximum demand. This demand is the peak which the C.E.G.B. has to meet, and which, in turn, determines the plant capacity which has to be provided and therefore the level of future capital charges.

A further refinement is that the chargeable demand of each area board will be the average of its contributions to the national simultaneous maximum demands before December 31 and after December 31 respectively in the year of account. This will help to meet the difficulty that charges based on a high single half-hour's demand may now be unduly onerous on one board whilst benefiting others if freak weather conditions occur in one part of the country. Under the prescribed demand feature, which is retained in the new tariff, the C.E.G.B. will receive from all the area boards collectively no more and no less than the estimated fixed costs, irrespective of the actual demands made.

It will be appreciated that the manner and extent to which such changes can be reflected in the detail charges to individual consumers or classes of consumer, depend on many other considerations and are the concern of the various area boards.

Progress in 50 c/s Traction Practice

During the Brazilian Federal Railways Conference in Rio de Janeiro last month, a paper entitled "Progress of Electrification at Industrial Frequency in Great Britain" was presented by Mr. J. A. Broughall, Assistant Chief Electrical Engineer, British Transport Commission. Dealing with developments too recent for inclusion in the British Railways Electrification Conference papers last year, Mr. Broughall said the opinion that the normal U.I.C. clearance for overhead equipment of 270mm static and 220mm passing would be satisfactory had been vindicated. They had made and were continuing experiments which they expected to prove that the clearance for 25kV could be reduced when desirable on grounds of economy to 203mm static and 152mm passing. This would materially reduce the occasions on which it would be necessary to have recourse to 6.25kV, thus simplifying train equipments and reducing the cost of power supply. Their opinion that 101mm static clearance and 76mm passing clearance, normal for 1500V d.c. traction, would be adequate for 6·25kV, has also been proved correct. They had, however, had some trouble with lines being earthed by birds and were now using auxiliary insulation when possible to reduce this nuisance.

Much importance was attached to the development of resin bonded glass fibre insulators and to the use of this material for section insulators. To be successful in the latter capacity, they must be fully resistant to the direct abrasion of the pantograph and capable of standing the imposed electro-mechanical stresses and occasional power arcs in the same way as the contact wire which they displaced. After six or seven years of intensive development, present designs indicated that these objectives were capable of realisation. It was extremely encouraging to record that during the many months of field experience at 25kV there had not been a single case of failure of a P.T.F.E.-protected glass-fibre insulator from any cause whatever, nor had it been necessary even under the most polluted climatic conditions to carry out any cleaning or other maintenance. Such savings and other advantages would more than compensate for some present additional cost.

Continuing to review developments in motive power, Mr. Broughall said that in a few months British Railways would have their first locomotive using static devices for the control of voltage to the traction motors. The scheme comprised silicon rectifiers instead of ignitrons, a transductor tap-changing scheme, and rheostatic braking. The essential feature was that two adjacent transformer tappings were connected to the load simultaneously, each connection having a self-excited transductor in series. By controlling the current in the low-power control windings of the transductor connected to the higher of the two taps, the load current could be steadily transferred from the lower to the higher tap, or *vice versa*, and therefore the traction motor voltage could be raised or lowered smoothly from zero to full value.

The smooth control of traction motor current allowed an effective increase in adhesion of 10 per cent or more, so that a 73-ton locomotive could start the same train as an 80-ton locomotive with conventional tap-changing. Secondly, the tractive effort/speed characteristics of the locomotive were much flatter than with ordinary tap changing. This again favoured adhesion, because the speed of a slipping wheel would be considerably reduced. Thirdly, only the magnetising current of the transductors, which was less than 10A had to be interrupted by the power contactors; therefore, arc chutes, blow-out coils, high-speed mechanisms, surges, ionisation and so on were eliminated. Fourthly, since the scheme was essentially one of low-voltage control, it had the inherent advantages of efficiency and power factor. Fifthly, the good performance in energy consumption was maintained unchanged for both the 6·25kV and 25kV overhead line voltages. With a 25kV tap changer, on the other hand, the energy requirements for a given performance were worse on the 6·25kV than on the 25kV overhead line.

This satisfactory performance of advanced techniques was a vindication of the view that the a.c. system, being in its initial stages of development, was the system which held most promise of improvement from the research and development projects now actively in hand.

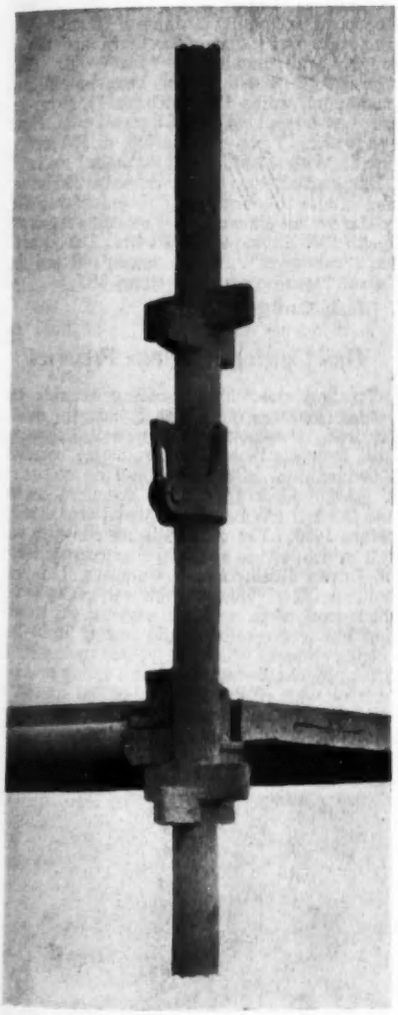
Speaking of protection, Mr. Broughall said the intention had been to reduce protective devices in the traction equipments to the minimum, but this objective had not yet been realised. Whilst some equipments were now considered to be over elaborate, other had needed additional apparatus. The motors of one fleet of motor coaches suffered considerably from over-voltages, particularly when working in the 6·25kV areas. These were due to transients developed by the rapid cut-off of the air blast circuit breaker with which every locomotive and motor coach was equipped. Most of this trouble disappeared as soon as a good earth was provided near the motors. The remainder would doubtless cease when capacity/resistor circuits had been fitted to absorb the over-voltages in question. Investigation was proceeding along two lines, one being preventive action as mentioned above, the other the modification of the characteristic of the circuit breaker so that, without reducing its fault clearing capacity or increasing its operating time, the over-voltages imposed on the circuit were materially reduced. One of the British Transport Commission's consulting engineers, Messrs. Merz and McLellan, had recently patented a form of resistance switching which showed promise by means of a simple modification of the existing circuit breakers of reducing these over-voltages from values lying between 50 and 70kV to values of the order of 30kV.

Diploma in Public Health Engineering

THE Institution of Public Health Engineers has introduced a new diploma in public health engineering. Arrangements have been made for candidates for this award to qualify academically through the examinations of the Institution of Civil Engineers. The Institution of Civil Engineers will sponsor public health candidates in the Engineering Institution Part I examination, which is administered by nine professional engineering bodies. Candidates for the new diploma will be required to pass Group A of Part II of the Institution of Civil Engineers examination which includes specialist public health subjects. To obtain the diploma candidates will also have to pass the professional interview of the Institution of Public Health Engineers, which has been modelled on that of the Institution of Civil Engineers.

Rapidly-Erected Scaffolding

A SYSTEM of scaffolding which virtually entirely eliminates loose fittings is now available from Kwikform, Ltd., and is known by the trade name of "Kwikstage." Although slightly more expensive in first cost than conventional tubular scaffolding, this new system, will, the firm considers, effect economies because of its



Two standards joined by wedge clamp, and the junction of the ledger and transom units

simplicity in use, and the speed with which it can be erected. A hammer is the only tool needed for erection or dismantling and no component exceeds 12ft in length or 38 lb in weight.

The "Kwikstage" system has been designed according to B.S. 1139 : 1951, and thus in principle has the same performance structurally as other systems. It has four basic components, which can be distinguished in the illustration ; they are as follows :

The Standard which, by definition, forms all the vertical members of a scaffolding, is 6ft 6in long and weighs 26 lb. It consists of a length of conventional scaffolding tube, but with "V"-shaped attachments welded on in "rosettes" of four, such that there are four "rosettes" on each standard. The tooth-like ends of the horizontal components fit into these "V"-shaped attachments, so a scaffolding platform can be constructed at any vertical interval of 1ft 7½in. The standard has provision for a screw-adjusted self-aligning baseplate at ground level. At its upper end it has a spigot joint, to which a wedge is pinned. The standard to be fitted above is dropped into the spigot, and the wedge then turned into position and knocked home to make the joint. This joint is shown in the centre of the illustration, with a "rosette" shown above it on the upper standard free of any other components, but a "rosette" on the lower standard shown carrying a platform.

The Transom ties the scaffold transversely, and consists, in the "Kwikstage" system, of two angles, joined back-to-back, with the special tooth-like bearing element with its captive wedge, fixed at each end. The transom weighs 22 lb, and it supports the standard battens on the flats of the angles. A transom is shown to the right of the standard in the illustration, the tooth-like bearing being fixed inside its appropriate "V" on the standard, with the wedge in position.

The Ledger, or longitudinal brace, is simply a length of scaffold tube with the same tooth-like bearing attachments as for the transom. A ledger is shown in position to the left in the illustration. Ledgers are also used as guard rails, positioned 3ft above the working platform.

The Batten consists of a standard 8ft length of board 9in wide by 2in thick. Battens rest on the flats of the transoms, again as shown in the illustration. The ends of the battens are bound to protect them, and they have pegs and slots at their mid points, to bind them together transversely.

Other Components.—Apart from the four basic components listed above, the system requires other components, all making use of the same method of jointing, which are principally as follows : tubular diagonal braces 12ft long ; "return units" for tying scaffolding runs together at right angles ; toe board bracket (for use with a standard batten as a toe board) ; "stage brackets," i.e. cantilevered platforms, two or three battens in width ; and a tie bar for use with the stage bracket.

A rate of erection of sixteen "squares" of scaffolding (i.e. an 80ft run to a height of 20ft) was achieved in five hours by two labourers previously unacquainted with "Kwikstage" recently, it is claimed.

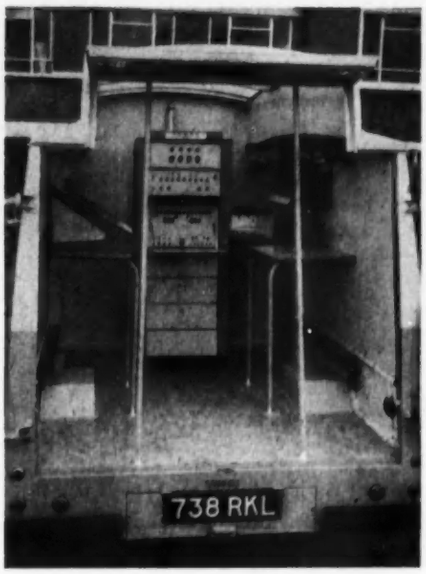
[Reply Card No. 1257]

Automatic Test Equipment

THIS month a demonstration set of automatic electronic production test equipment developed by the Autotest Division of Elliott Brothers (London), Ltd., is beginning a tour of electronic and aircraft firms. The equipment, seen in our illustration mounted in its demonstration van, is based on the apparatus described in our January 27, 1961 issue, page 138, and has been given the name "Score." The Autotest Division responsible for its production is based at Airport Works, Rochester, Kent.

In addition to continuity and resistance tests, "Score" provides for measurement on the production line of resistance, capacitance and inductance in complete circuit assemblies, either in wired or printed form. It is designed on the unit system so that increased capacity and range of tests can be provided by addition of further units to an existing installation. Test programmes are stored on a sixteen-track magnetic tape unit.

The basic "Score" is capable of performing a continuity test between a maximum of 198 terminations. Selection may be direct, line to line, or, with a parallel-connected switchbox, from any line to any other line. Line termination capacity is increased, in increments of 200, by addition of standard switchboxes. The scanning system is based on the use of dry reed relays driven by transistor counting chains and giving a normal rate of switching of 50 c/s. Facilities are provided for latching selected



Apparatus for cableform and circuit wiring tests in demonstration van

groups of relays when making group insulation or continuity tests.

The basic "Score" control unit incorporates a 200-termination switchbox. Digital displays are provided on the front panel, and below these are rotary ten-position pre-determining switches which enable a chosen number of tests to be run through automatically or step-by-step, or provide an instantaneous re-set position. All remaining controls are push-buttons, including those which determine whether the counters are stepped or allowed to run continuously at 50 c/s.

[Reply Card No. 1256]

Sensitive Ion Detector for Mass Spectrometer

ACCURACY that is not limited by background "noise" is claimed for a sensitive ion detector for mass spectrometers, which has been invented at the Atomic Weapons Research Establishment (U.K.A.E.A.), Aldermaston. In certain conditions this ion detector can distinguish between the required ions and those undesirable ions which constitute a large part of the background "noise."

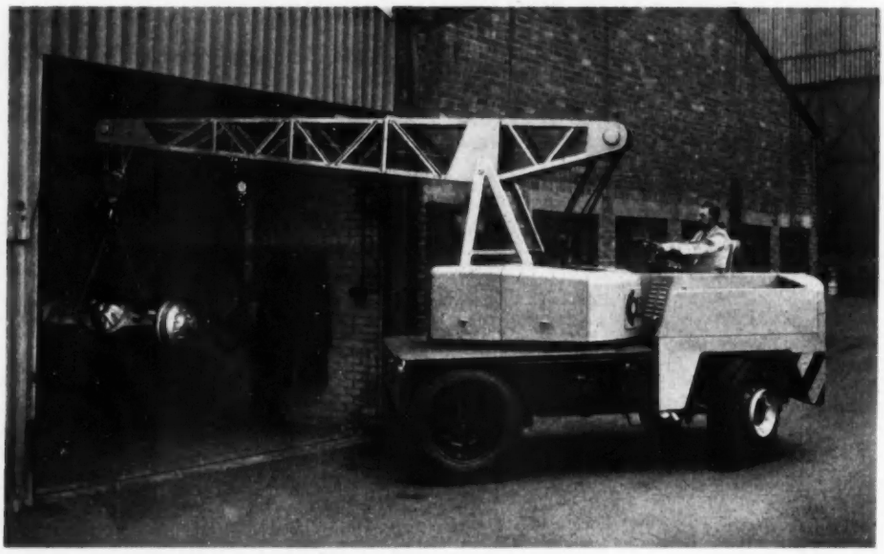
These background ions may have the same e/m value as the desired ions or they may be ions with a very different e/m that reach the ion detector because they have been scattered or dissociated by the residual gas or walls of the spectrometer. Their elimination increases the sensitivity of the apparatus and makes it less difficult to distinguish signals due to those components of a mixture which are present only in small proportions. One application of this principle results in a more sensitive leak detector for ultra-high-vacuum work.

Briefly the ion detector consists of a vacuum chamber containing a thin metallic foil at a high negative potential. The thickness of the foil is such that the desired ions will penetrate and liberate secondary electrons from the back of the foil. An electron detector receives these secondary electrons to produce the measured signal. Unwanted ions are unable to penetrate the foil sufficiently to release secondary electrons and in this way the background signal is eliminated.

Further information is available from the Patents Licensing Officer, U.K. Atomic Energy Authority, 11, Charles II Street, London, S.W.1.

[Reply Card No. 1240]

SHORTER REPORTS *(Continued)*



" Leda " mobile crane equipped with " cantilever " jib

Mobile Crane of 4 Tons Nominal Capacity

A PROTOTYPE of a new diesel-electric mobile crane just introduced by Steels Engineering Products, Ltd., is shown in the illustration. The crane is known as the Coles " Leda," and it is made in two versions, one having a " cantilever " jib as shown in the illustration, and the other having a " strut " jib, i.e. a jib pinned to the base of the slewing superstructure at its front, and held by blocks and tackle from an " A "-frame which overhangs the rear of the superstructure. The crane is noteworthy for its high travelling speed (top speed 17·6 m.p.h.), its general maneouvrability (it has a turning radius of 12ft) and compactness. It is operated by one man and as can be seen, it is a full-circle machine, the superstructure protruding only 1in beyond the width of the chassis when rotated.

The " Leda " is powered by a four-cylinder Ford diesel engine of 3·61 litres capacity, developing 52 b.h.p. at 1800 r.p.m. (maximum torque 158 lb ft at 1500 r.p.m.). From the engine the drive is transmitted to the twin driving wheels by a hydraulically-operated semi-centrifugal single dry plate clutch, a four forward speed and one reverse speed gearbox (possessing synchromesh on second, third and fourth gears), an open propeller shaft fitted with universal joints and thence to the driving axle. The driving axle is a double reduction device with primary spur gearing and secondary hypoid bevel drive, equipped with a normal differential and fully floating axle shafts, and is solidly mounted to the chassis frame.

The steering axle, on the other hand, is suspended from the chassis frame by wide based coil springs and is equipped with hydraulic shock absorbers. It comprises an alloy steel beam carrying the stub axles in phosphor bronze bushes, with the wheel hubs mounted on taper roller bearings. Steering is achieved by a cam and double roller gearbox which is assisted by an axle-mounted hydraulic ram served by a gear pump belt-driven from the engine. Both the steering axle wheels and the driving wheels are fully interchangeable, a feature uncommon in current crane practice. All tyres are $8{\cdot}25 \times 20$ and are mounted on pressed steel ventilated wheel discs.

Foot-operated, hydraulically applied brakes act on all wheels and a hand-operated mechanical parking brake acts on the driving wheels only. These brake controls, together with the clutch pedal, gearshift, generator power-take-off and crane motion electric pilot switches, are all readily reached from the one driving position. The two self-centralising " finger-tip " pilot switches, which bring into operation interlocked heavy-duty reversing contactors, are situated convenient to the driver's hand and are considered by the maker to be of particular interest. One combined pilot switch operates both the hoist and slewing motions and the other single switch the derricking action. The combined two-motion pilot switch (which was designed specifically for the " Leda ") will, it is claimed, enable the operator to speed up handling cycles.

The electrical transmission for the crane motions commences at a power take-off from the gearbox to the generator. The generator is slung below the chassis, and is a variable voltage/variable speed machine operating in the range 0–400V. Of the three motions which it powers, namely hoisting, derricking and slewing, the slewing motor and slewing brake are also slung below the chassis. The hoisting and derricking motors and their respective brakes are mounted on the superstructure and are interchangeable. The maximum output of the slewing motor is $1\frac{1}{4}$ h.p., and of hoisting and derricking motors each 10 h.p. The brakes for these motions are electro-mechanical, the shoes being controlled by solenoid coils. They operate automatically to hold the load should the power fail. The superstructure also carries the contactor gear, and ballast, but the principal ballast is underslung and is positioned across the full width of the rear of the vehicle, as shown by the stripes painted on the right of the crane in the illustration.

The crane revolves on a large diameter double live ring of steel balls running in hardened races. This double race ball bearing obviates the need for a centre post.

Normal driving routine is to engage the pilot switches for the motion or motions desired while the engine is running at reduced speed and thereafter to control the speed of the motion by varying the engine speed through the accelerator. As the engine is accelerated the appropriate electro-mechanical brakes are automatically released. In addition, automatic protection is incorporated to safeguard the machine against abuse. This permits the driver to select any motion, irrespective of the engine speed, and introduce it without shock to the electrical or mechanical components of the crane.

Typical B.S. operating speeds quoted for the " Leda " are hoisting on single line 112ft per minute for 1 ton and 150ft per minute for $\frac{1}{2}$ ton. Derricking, maximum to minimum radius, takes twenty-five seconds laden and fifteen seconds unladen ; slewing at 2 and 3 r.p.m., respectively.

In the " cantilever " version of the crane as illustrated, 4 tons can be lifted at a radius of 7ft to the front, or 6ft to the side (the " outreach " is respectively 3ft 3in and 2ft 4in in these two positions) based on B.S. 1757. Taking 85 per cent of the tipping load as the criterion of safety, the 4-ton load may be increased to 11,000 lb for the same distances. The cantilever jib can be nominally either 11ft 3in, 15ft or 20ft long, giving maximum radii of 12ft, 15ft 9in and 20ft 9in respectively. With the largest, a B.S. load of $\frac{7}{8}$ tons can be carried at a radius of 20ft 9in to the front of the crane, and a load of $\frac{5}{8}$ tons to the side at the same radius. The weight of the cantilever version of the crane (with basic jib and in travelling order) is 7 tons 16 cwts.

When the " Leda " is fitted with the " strut " jib, two methods of operation become possible, either " free," with the crane fully mobile, or " blocked," with outriggers bearing on blocks at two points on each side of the crane, giving a base width of 10ft 4in. Four tons (B.S.) can be lifted at a radius of 8ft when the crane is " blocked." In the " free " condition, 2 tons (B.S.) can be lifted at a radius of 7ft and 8ft 9in, over side and front respectively, and this is roughly the maximum " free " lift. The " strut " jib would, in this case, be 20ft long (maximum radius 19ft " blocked "), giving the crane an overall weight of 8 tons 2 cwts. However, " strut " jibs of 30ft, 40ft, or 50ft may be fitted. With a 50ft jib and the crane " blocked," a B.S. load of $\frac{1}{4}$ ton can be carried at 30ft radius, that is, also to a height slightly greater than 40ft.

The overall dimensions of the crane chassis are length 13ft 3in and width 7ft 4in. The height of the " cantilever " is just under 10ft and the " strut " version when travelling, 8ft.

[Reply Card No. 1245]

Gas Cutting Machine Preserved

To find the oldest working Hancock gas cutting machine in Great Britain the manufacturers, Hancock and Company (Engineers), Ltd., Progress Way, Croydon, Surrey, organised a competition, with a new profiling machine as a prize. Over fifty firms submitted entries, and the first ten machines entered were all made before 1930. The oldest discovered, which was still in regular use at the Wolverhampton works of Davies Brothers and Company, Ltd., was built in 1924. This machine will cut up to 4in thick steel plate, with an oxy-coal gas burner, and has a two-to-one ratio tracing arm. The tracing wheel, which is guided manually, is driven by clockwork, and has a spring governor control with a speed range of 6in to 14in a minute. The machine has been presented to the Museum of Science and Industry, Newhall Street, Birmingham, 3.

Oxy-coal gas profiling machine built in 1924

INDUSTRIAL NEWS

United Kingdom Direct Investment Overseas

Estimates of the direct investment by British industry overseas during 1960 and of direct investment by overseas interests in the United Kingdom have been published by the Board of Trade. These estimates revise the provisional figures for 1960 included in the balance of payments White Paper (Cmd. 1329) published last March and will be incorporated in the next balance of payments White Paper to be published in October.

In 1960 direct investment overseas by United Kingdom companies totalled £249 million, the Board says, 27 per cent more than in 1959 and nearly three-quarters more than in 1958, whilst investment in the United Kingdom by overseas companies in 1960, at £141 million, was roughly the same as in 1959. The Board points out that the Ford Motor Company acquisition is not included in the 1960 figures since the direct investment transactions associated with it took place in the first half of 1961.

During 1960 the United Kingdom balance of payments benefited on current account to the extent of £122 million from earnings on direct investment, compared with £102 million in 1959 and £100 million in 1958. These figures represent the excess of earnings of United Kingdom direct investment abroad over those of overseas direct interests in the United Kingdom. Earnings of overseas branches, subsidiaries and associates of United Kingdom companies rose from £238 million in 1959 to £258 million in 1960, an increase of 8 per cent. This was smaller than the increase between 1958 and 1959 when earnings rose by 22 per cent. Overseas interests in the United Kingdom appear to have fared less well, the Board says, their earnings in 1960 being the same as those in 1959, whereas between 1958 and 1959 there had been an increase of 43 per cent.

Planning Economic Resources

In a speech to the North Midland Regional Council at a luncheon held at Leicester last week, Mr. C. E. Harrison, president of the Federation of British Industries, said that current public discussions arising from Britain's recurring balance of payments problems, laid great stress on the need for more exports and for greater productivity, and gave a picture of a Britain that was failing to live up to the pace of modern conditions. But this overall picture was based on generalisations which were applied indiscriminately to the whole of British industry, he suggested, and like all generalisations they were false in many instances. British industry had no need to be ashamed of its export performance, Mr. Harrison said. In 1958 exports were valued at £3392 million, in 1959 at £3509 million, in 1960 at £3711 million, with the first quarter of 1961 showing a slight increase on the same period in 1960. Examination of the balance of payments figures shows that the deficit in 1960 was caused more by a large increase in imports than by any failure to expand exports. Furthermore, he added, government spending abroad absorbs virtually all the surplus on invisible transactions which in the past offset our adverse trading balance. If, therefore, a solution was to be fonnd to present difficulties, Mr. Harrison said, it was not enough to exhort industry to greater efforts.

On the other hand, Mr. Harrison continued, there was a growing volume of evidence which indicated that Britain was not progressing as fast as it should in a world where standards of production and the volume of import/export trades were rising rapidly. Britain was beginning to lose in certain markets because of high costs. Since November, however, Mr. Harrison stated, a group of authoritative people under the chairmanship of Sir Hugh Beaver, had been considering these problems in greater detail, and consequently the Federation of British Industries was ready to discuss in a constructive fashion the Chancellor's proposals for planning economic resources (THE ENGINEER, October 6, 1961).

Whilst the Federation attached importance to the preparation of plans, Mr. Harrison said, it also wanted consideration to be given to all the impediments to production which industrialists had to face, including such subjects as the effect of taxation and restrictive practices. The Federation believed, he added, that any attempt to impose control would meet with disaster. What it wanted was a free association of government, industry and the unions discussing how best to increase the volume of national wealth.

Scholarship Awards

The United Steel Companies, Ltd. has awarded five university scholarships, following a final selection board held in Sheffield, at which a short list of twenty candidates was interviewed out of a total of 201 applicants. The scholarships are tenable for three or four years and are to the value of £500 per annum, free of tax. It is intended that they should provide industrial as well as academic training, and arrangements are to be made for the successful candidates to receive industrial experience with the company.

This is the second annual award of United Steel scholarships, five being awarded in 1960.

Employment

According to the latest figures published by the Ministry of Labour the number of people in civil employment in Great Britain is estimated to have increased during August, 1961, by 84,000 to the highest ever total of 24,000,000. An increase of 43,000 people employed in the manufacturing group of industries included an increase of 16,000 in the engineering and electrical goods sector. Outside the manufacturing industries employment increased in most industries and services, the Ministry says, the greatest increases being 13,000 in the financial, professional, scientific and miscellaneous services, 11,000 in the construction industries and 11,000 in the distributive trades. The August, 1961, figure for civil employment is about 193,000 higher than the corresponding figure for August, 1960.

In the week ended August 26, 1961, the estimated number of operatives working overtime in establishments with eleven or more employees in manufacturing industries, excluding shipbuilding and ship-repairing, was 1,775,000, each working eight hours overtime on average. This estimate was 12,000 more than at the end of July. In the same week, the Ministry states, the estimated number of workers on short time in these establishments was 39,000 each losing 11½ hours on average. This estimate was 10,000 more than at the end of July.

Regional Control of British Waterways Suggested

The National Association of Inland Waterway Carriers has sent a statement of its views on the forthcoming reorganisation of the British Transport Commission, to the Minister of Transport. The Association is critical of the effectiveness of a central organisation for controlling the canals. Referring to the three classes of waterways enumerated by the Bowes committee in 1958 (namely (i) those which pay commercially and are worth developing ; (ii) those with light traffic, but worth maintaining ; and (iii) those with little value except for water supply, recreation, &c.) the Association states, as its strong opinion, that " the problems attendant on these three aspects of the waterway system cannot be efficiently dealt with by a central authority in London but only by reverting to the policy of on-the-spot administration as was the case prior to nationalisation. Each Division of British Waterways with its commercial, estate, water, and other functions is, in comparison with any organisation, a sufficiently large unit for effective administration . . . there is little in common between the present Divisions of British Waterways to necessitate a large central organisation. This can but stultify action in many directions. The Association holds the view that the inland waterways can best be managed by giving maximum powers to administrative bodies to be set up in the regions and to re-introduce into the bodies contact with industry and commerce which was lost on nationalisation."

A scheme of organisation based on these principles is suggested, with regional boards, representative of industry, commerce, carriers, and where appropriate, " amenity and other users."

Laid-up Shipping

Figures issued by the Chamber of Shipping of the United Kingdom show that laid-up shipping throughout the world at the beginning of September, totalled 299 ships representing 2,549,669 tons gross or 2 per cent of the world fleet. This total includes 111 dry cargo ships of 581,962 tons gross and 188 tankers of 1,967,707 tons gross. The corresponding totals for Great Britain are forty-one ships of 323,819 tons gross which includes fifteen dry cargo ships of 104,149 tons gross and twenty-six oil tankers of 219,670 tons gross. Of the world total post-war built ships account for eighty-seven ships of 982,132 tons gross of which eleven ships of 74,800 tons gross are dry cargo and seventy-six ships of 907,332 tons gross are oil tankers.

PERSONAL AND BUSINESS

Appointments

MR. ALEXANDER JOHNSTON has been appointed public relations manager to Bristol Siddeley Engines, Ltd.

MR. H. STEWART, has been appointed to the board of Cox and Danks, a company in the Metal Industries Group.

PYRENE-PANORAMA, Ltd., announces that Miss B. P. Park, has been appointed sales manager of its eye protection department.

THE INSTITUTE OF INDUSTRIAL SUPERVISORS announces the appointment of Mr. F. A. J. Taylor as an education officer.

THE PLESSEY COMPANY, Ltd., announces the appointment of Mr. R. L. Higgin, A.M.I.E.E. as general manager, components group.

DR. J. W. MENTER, F.Inst.P., has been appointed director of the Tube Investments Research Laboratory at Hinxton Hall, near Cambridge.

RICHARD SUTCLIFFE, Ltd., announces the appointment of Mr. William Leeman as technical sales representative for the Midland Counties.

MR. JACK WHITE, formerly with Mullard, Ltd., in the commercial section of its semiconductor division, has now moved to Texas Instruments, Ltd., Bedford, as sales administration manager.

THE BRITISH BROADCASTING CORPORATION announces the appointment of Mr. L. G. F. Shuttleworth as engineer-in-charge of the Tatsfield Receiving and Measurement Station in succession to the late Mr. H. V. Griffiths.

MATTHEWS AND YATES, Ltd., has appointed four new assistant directors : Mr. L. Barton, A.M.I.H.V.E. ; Mr. A. B. Crompton, A.M.I.H.V.E. ; Mr. G. L. Jaques, A.M.I.Mech.E., A.M.I.H.V.E. ; and Mr. L. Winstanley, A.M.I.Mech.E., A.M.I.H.V.E.

MR. C. R. TEARNE, formerly technical sales manager of Churchill Gear Machines, Ltd., of Blaydon-on-Tyne, has been appointed director of the company. Other new appointments at Churchill Gear Machines, Ltd., are, Mr. W. Guss as technical sales manager, Mr. T. Lewins as chief machine tool designer, and Mr. P. Wedgwood as chief engineer.

SIR WILLIS JACKSON, who since 1953 has been director of research and education of Associated Electrical Industries (Manchester), Ltd., relinquished his appointment on September 30 to return to academic life as Professor of Electrical Engineering at Imperial College, University of London. Dr. J. M. Dodds has been appointed director of the A.E.I. Research Laboratory, Manchester.

HOLDEN AND BROOKE, Ltd., states that Mr. R. A. Brooke has relinquished the position of works director and assumed responsibility as commercial director. Mr. F. L. Taylor has been appointed to the few post of production controller. His duties in connection with sales matters have been undertaken by Mr. M. Beesley. Mr. S. N. Clift has retired from his post as Northern area outside sales manager, Mr. S. K. Hallworth having been appointed to this position.

THE TURNER AND NEWALL GROUP has announced that Mr. J. Waddell, executive director of Turner Brothers Asbestos Company, Ltd., and of Glass Fabrics, Ltd., has been appointed managing director of each company. He continues to be the executive director of J. W. Roberts, Ltd. Mr. E. R. Pochin, home sales director of Ferodo, Ltd., has been appointed managing director of that company. Mr. M. H. Good, the home sales manager, has been appointed home sales director of Ferodo, Ltd., in place of Mr. E. R. Pochin.

THE MINISTRY FOR SCIENCE announces the appointment of five new members of the Council for Scientific and Industrial Research. They are Mr. L. H. Bedford, director of engineering, guided weapons division, English Electric Aviation, Ltd. ; Mr. G. B. R. Feilden, managing director, Hawker Siddeley Brush Turbines, Ltd. ; Professor E. R. H. Jones, Waynflete Professor of Chemistry, Oxford University ; Professor O. A. Saunders, Professor of Mechanical Engineering, Imperial College, London ; and Mr. H. C. Tett, chairman and managing director, Esso Petroleum Company, Ltd. Three members who have completed their five-year term of office, retired on September 30 : the former chairman, Sir Harry Jephcott, chairman of Glaxo Laboratories, Ltd. ; Professor C. E. H. Bawn, Professor of Inorganic and Physical Chemistry, Liverpool University ; and Sir Willis Jackson, at present director of research and education, A.E.I. (Manchester), Ltd. A fourth member, Sir Walter Drummond, who was also due to retire on September 30, has been reappointed for a period of three months.

BABCOCK AND WILCOX, Ltd., announces that Sir Eric Mieville is retiring from the chairmanship of Dewrance and Co., Ltd., on December 31, 1961. The present deputy chairman, Sir Donald Perrott will succeed Sir Eric Mieville as chairman. Sir Francis Evans is also retiring from the board. Mr. J. B. W. Cunningham has been appointed managing director and will take up duty towards the end of January. Mr. Cunningham is at present managing director of the engineering group of the United Kingdom Atomic Energy Authority.

MR. WILLIAM DOUGLAS TAYLOR joined the Society of Motor Manufacturers and Traders on September 18 as overseas secretary and manager, British manufacturers section, in succession to Mr. Donald Mark Tailby. Other changes at the Society include the appointment of Mr. John David Wright Gent as head of the legal department in succession to Mr. R. S. Weir who leaves the Society at the end of October ; the retirement of Mr. A. J. Simpson who has been the society's representative for South Africa for over twenty-six years ; and the resignation—to take effect as from February 28, 1962—of Mr. B. G. J. Clarke who was appointed representative for New Zealand eight years ago.

THE LANCASHIRE STEEL CORPORATION, Ltd., announces that Sir John James has retired from the chairmanship of the Corporation, a position which he has held for the past thirty years, and also from the chairmanship of the principal subsidiary companies. Mr. Philip Holloway who has been associated with the Corporation for many years, and a director since 1951, has been appointed chairman of the Corporation and of its principal subsidiary companies, Lancashire Steel Manufacturing Company, Ltd., Rylands Brothers, Ltd., Whitecross Company, Ltd., and The Pearson and Knowles Engineering Company, Ltd. On taking up these appointments he has resigned from the position of managing director of Lancashire Steel Manufacturing Company, Ltd., and Mr. G. Barrington Thomas has been appointed managing director. Mr. Thomas has also been appointed to the Board of The Lancashire Steel Corporation, Ltd. The Corporation also announces that Mr. G. K. Rylands the joint managing director of Rylands Brothers, Ltd. and Whitecross Company, Ltd., has retired and Mr. R. S. Bleckly the other joint managing director has been appointed managing director of both companies.

CENTRAL ELECTRICITY GENERATING BOARD, S.E. REGION, announces that Mr. H. B. Laine, M.I.E.E., has been appointed regional electrical engineer as from September 1, 1961. Mr. Laine is responsible to the deputy regional director for the planning and construction of all local transmission reinforcements and new supply points in the South Eastern Region and for the supervision on site of projects initiated by the chief transmission project engineer. This work will be divorced from the operation and maintenance of the transmission system which will remain the responsibility of assistant regional directors. The following appointments have also been made with effect from September 1, 1961 : deputy regional electrical engineer, Mr. J. W. Carroll, A.M.I.Mech.E., A.M.I.E.E. ; transmission project engineer (North Thames), Mr. B. Farnworth ; transmission project engineer (South Thames), Mr. E. P. Cardew ; system development engineer, Mr. R. S. Oliver, A.M.I.E.E. North Thames Division : transmission engineer (operation and maintenance), Mr. D. W. Lackie, M.I.E.E. ; technical engineer, Mr. A. E. Lane, A.M.I.E.E. South Thames Division : transmission engineer (operation and maintenance), Mr. W. G. Todd, M.I.E.E. ; technical engineer, Mr. G. S. H. Jarrett, A.M.I.E.E.

Business Announcements

THE A.P.V. COMPANY, Ltd. and A.P.V.-PARAMOUNT, Ltd., announce that on October 25, 1961, at 1 p.m. their telephone number will be changed to Crawley 27777 when Crawley's telephone service becomes automatic.

MR. HARRY JOHNSTON, chief engineer to the North Eastern Gas Board, has retired after being connected with the gas industry for 45 years. The Board will still be able to call on his services as a part-time Consultant.

MR. FRANK A. RAWLINGS, a deputy to the financial adviser to the Electricity Council, retired from full time service with the Council on September 30, 1961 after fifty years in the public services, forty-seven of which were spent in association with electricity.

LAPORTE CHEMICALS, Ltd., a subsidiary of Laporte Industries, Ltd., has entered into an agreement with the Spanish company, Peroxidos S.A., to provide technical assistance and advice on the construction of an autoxidation hydrogen peroxide plant near Saragossa in Spain.

THE POWER-GAS CORPORATION, Ltd., Stockton-on-Tees, a member of the Davy-Ashmore Group, has been appointed main contractor by Magnesium Elektron, Ltd., for the engineering of a new plant to produce 5000 tons per annum of magnesium at Hopton, near Wirksworth, in Derbyshire.

PATERSON HUGHES ENGINEERING COMPANY, Ltd., announces the retirement of Mr. Gilbert Bealing, after 17 years' service as its chief sales engineer for London and south of England. His work in the paper industry will be taken over by Mr. D. J. Hill, G.I.Mech.E., and in other industries by Mr. C. Jackson.

THE UNITED STEEL COMPANIES, Ltd. announces that on September 30, the assets and liabilities of Owen and Dyson, Ltd. were transferred to The United Steel Companies, Ltd. The business of Owen and Dyson is now being undertaken by Steel, Peech and Tozer, and the new department thus created will be known as the Fullerton machine shops.

METAL INDUSTRIES, Ltd., has announced the setting up of a new company in Canada. to be known as Dominion M.I., Ltd. It will have its head office and works in Montreal with a branch office and repair department in Toronto. President and general manager of the new company, will be Mr. E. A. Chandler ; general sales manager will be Mr. D. J. Tamblyn.

UNIVERSAL GRINDING WHEEL COMPANY, Ltd., has formed a new subsidiary company named Sparcatron (Manufacturing), Ltd., which has taken over the occupation of a new factory at Tuffley Crescent, Gloucester, specially designed for the manufacture of Sparcatron machines previously made by another subsidiary, Impregnated Diamond Products, Ltd.

LOCKHEED AIRCRAFT CORPORATION has reached an agreement with Petro-Tex Chemical Corporation, Houston, Texas, to acquire complete ownership of Grand Central Rocket Company. Lockheed already has a 50 per cent interest in Grand Central. Grand Central Rocket is a producer of solid propellant rockets. The company will be operated as a division of Lockheed.

THE LONDON ALUMINIUM COMPANY, Ltd., BETTS AND CO., Ltd. (a subsidiary of Courtaulds) and ENFIELD ROLLING MILLS (ALUMINIUM), Ltd. (a subsidiary of Enfield Rolling Mills, Ltd.) announce that arrangements have been made for Betts and Enfield Rolling Mills (Aluminium) to acquire through a new company to be owned by them jointly the business of one of the London Aluminium Companies subsidiary companies, London Aluminium (Containers), Ltd., which manufactures aluminium aerosol containers and other aluminium impact extrusions. It was proposed that the new company, to be called Metal Impacts, Ltd., should take over the business with effect from October 2, 1961.

PRAT-DANIELS (STROUD), Ltd., of Nailsworth, Gloucestershire, is to hold a private exhibition at the Birmingham Engineering Centre (Stephenson Place, New Street, Birmingham 2), on the evenings of Wednesday and Thursday, October 25 and 26 1961, in order to display its existing range of fans and dust collecting equipment, together with models of the latest plant now being designed and developed for fume and dust suppression. The exhibition will be open from 10 a.m. all day on Thursday October 26, the main part, however, will be from 5.30 p.m. to 9.0 p.m. on each of the two evenings, when staff will be on duty to assist visitors from industry who have been personally invited.

Deaths

WE regret to announce the death of Mr. W. Jenkins Gibson, J.P., financial director of Hadfields, Ltd., and deputy managing director of its subsidiary company, Millspaugh, Ltd. Mr. Gibson, who was sixty-three, was born in Glasgow, and qualified as a chartered accountant while on the staff of Peat, Marwick, Mitchell and Co. in that city. He was transferred to the Sheffield office of Peat, Marwick, Mitchell in 1922, and joined Hadfields, Ltd., as assistant to the secretary in 1927.

WE also regret to record the death of Mr. Arthur Sunderland, who was with Frank Wigglesworth and Co., Ltd., Shipley, for thirty-two years, and a director of the firm since 1953. Mr. Sunderland was sixty-six.

CONTINENTAL AFFAIRS

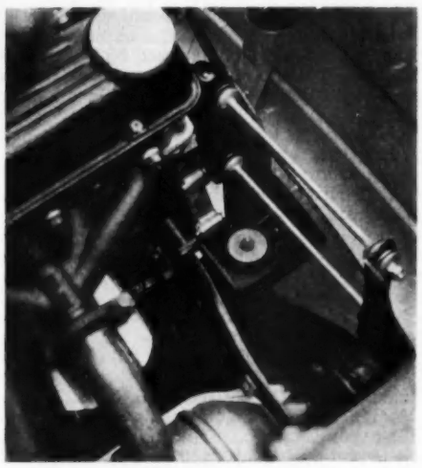
by Our Continental Editor

48th Salon de L'Automobile

THE Paris Motor Show which opened on October 5 and continues to October 15, in the Grand Palais off the Champs Elysées, is the forty-eighth in sequence of the oldest international exhibition devoted to the motor industry. The exhibition this year excluded commercial vehicles, cycles and motor cycles, although many of the accessories were, of course, applicable to such vehicles. The exhibition was highly international, nearly one quarter of the 800 exhibitors being foreign, and in fact the ten native manufacturers were outnumbered by those of Britain (twenty-six), the United States (fifteen), and Germany (thirteen). It should however be recalled that no fewer than four of the French manufacturers produced over 120,000 vehicles in the first six months of this year, namely Renault (209,335), Citroen (175,779), Peugeot (129,622), and Simca (120,923); each of these totals includes over 10^5 private cars. The production of cars and light commercial vehicles in France is, however, much lower than in 1960, the totals for the first halves of this and last year being 555,136 and 639,651; this difference is to be found in the output of the Régie Nationale des Usines Renault, the production of "Dauphine"/"Floride" cars falling from 257,720 to 175,760 and of the 4 c.v. from 29,184 to 9,267. The 4 c.v. has, of course, now been superseded by a utility car with the power unit transferred from back to front, the new R4 and the R3 with the small-bore 603 c.c. engine. This design, it may be anticipated, will be sold easily only where its virtues of accommodating bulky objects and of needing a minimum of attention are important, because in France alone two new passenger cars in the under 1000 c.c. class have been placed on the market, the "AMI-6" backed by the decades of experience of Citroen with *traction avant*, and the Simca "1000" derived from the well established Fiat 600.

The new Simca is distinctly larger than the Fiat, having an engine of 944 c.c. instead of 767 c.c., and it is a four-door saloon with the doors opening forwards. The front of the car is composed of a broad high "bonnet" which is in fact the boot, and the luggage space behind or, by folding down the seat back, on the rear seats has been rejected in the new design. This change has reduced the weight and cost of glass in the car, and been amply vindicated by allowing the same press tools to be used for forming the main panels at both ends of the car, although this means that engine accessibility is little better than to a unit mounted between body and radiator. The car is, moreover, too small to allow this economy in overheads to be carried to the stage more frequently attained of having symmetrical front and rear doors. The front and rear wings are secured by bolts to allow easy repair of damage.

The engine can be regarded as a short-stroke linered-down version of the "Rush" unit," having a 68mm bore and a five-bearing crankshaft of 65mm stroke, with a centrifugal oil filter on the end of the crankshaft (as also, of course, on Fiat cars). The general arrangement is that of the Fiat, with the water pump mounted on a long extension pipe to bring the fan to the side of the engine, but the plane of the cylinder block is inclined 10 deg. away from the fan; the auxiliary drive is also different, the generator pulley acting as an adjustable jockey in the fan drive instead of the fan being driven from the generator by its own belt. To prevent the same



Rear end of Simca engine, showing coil spring and rubber-mounted locating linkage. Notice that the exhaust manifold can be removed sideways relative to the studs

The curiously unaerodynamic envelope of the Simca 1000 can be explained by comparing the appearance of the front (left) and the back (right)

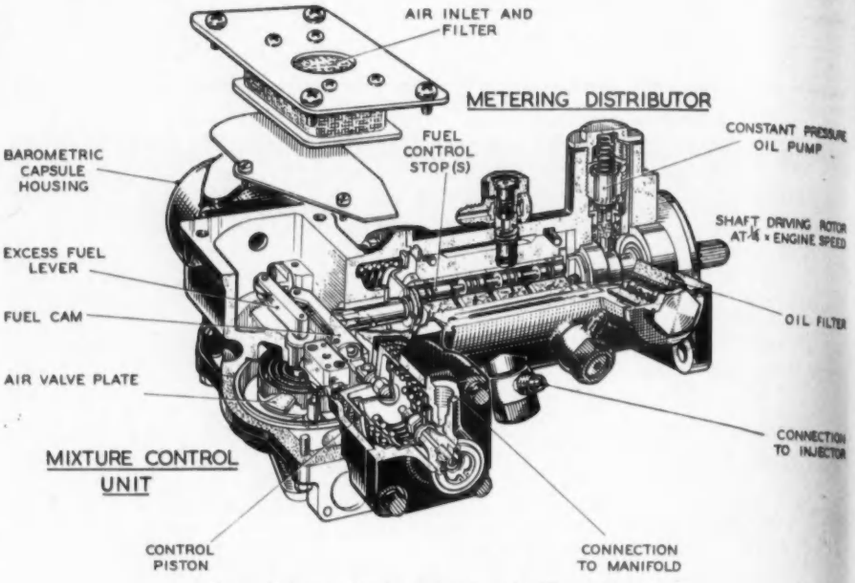
CONTINENTAL AFFAIRS *(Continued)*

air circulating through the radiator repeatedly, the heated air is directed to the louvres on the left hand side of the bonnet ; those on the right hand side are baffled to prevent free access of rain and snow to the power unit.

A particular feature of the rear-engined Fiat cars is, of course, the resilient mounting of the engine, and in the Simca " 1000 " the weight of the engine rests not on rubber blocks but on coil springs in compression. These mountings are extremely flexible, it being easy to rock the engine up and down through a range of inches, and hence the engine is located by a relatively rigid linkage, as seen in our illustration. Since the driving wheels are located not by the swing axles but by wishbones on axes passing through the universal joints, the power unit experiences no fore and aft forces other than those due to its mass. The suspension of the front wheels is as on the Fiat saloon, a transverse leaf spring being anchored at two points well separated to generate roll stiffness ; the steering swivels are ball joints.

The Simca " 1000 " weighs 1602 lb equipped and runs on 5·60×12 tyres, inflated to 1·1 kg and 1·6 kg per square centimetre respectively front and back ; it has a turning circle of less than 30ft and a maximum speed of 75 m.p.h. is claimed. The use of a relatively heavy engine, with a cast iron block and water cooling, of as much as 950 c.c. in a rear engined car is clearly an innovation of particular interest in this country, but we have, we regret, had no opportunity to drive the car and observe whether it offers the handling characteristics associated with this make.

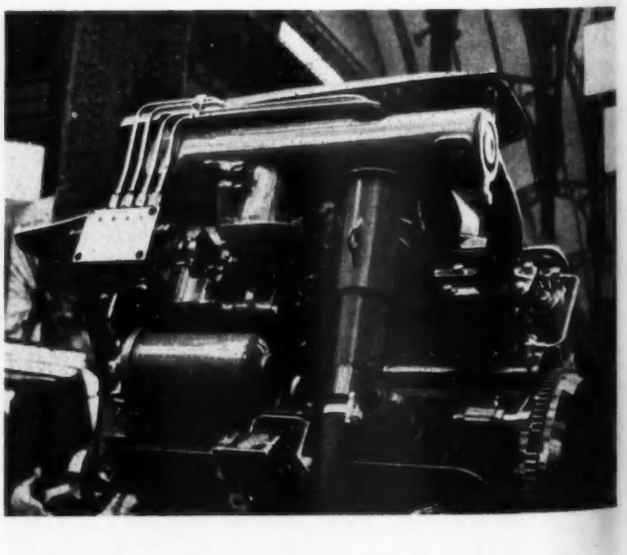
Also at the Salon was the new Lagonda " Rapide " which differs almost wherever possible from the previous Lagonda design of W. O. Bentley ; in particular, it has de Dion final drive instead of independent rear suspension. It is possible to look upon the new Lagonda as an enlarged version of the Aston Martin ; it has the seven-bearing twin-camshaft wet-liner light-alloy engine of the DB4 enlarged to 3995 c.c., to give 236 h.p. at 5000 r.p.m., and a speed of over 125 m.p.h. is claimed. There is an option of an all-synchromesh four-speed gearbox or a Borg-Warner automatic transmission, in each case with a final drive of 3·77 ; the manual transmission is accompanied by a twin plate clutch. As on the 2·6 litre car, separate master cylinders operate front and rear brakes, which in this case are Dunlop discs. The body work is " Superleggera," of aluminium alloy panels on a steel tube structure, and twin fuel tanks in the rear wings give a capacity of 16½ gallons. The interior equipment is luxurious, and includes Kuyper reclining front seats. The electrical system (which includes the tachometer) is of interest ; of the four headlamps, two are of 7in diameter and are of glass-envelope construction, while the other two are 4·75in diameter with metal reflectors but the bulbs permanently fixed to allow mechanical aiming—these latter have not filament but bulb shields to prevent light from the filament passing direct to the lens.



Lucas fuel control unit as fitted on the Maserati engine

Another new British product was an estate car based on the Ford " Anglia " saloon. This vehicle shows evidence of quite different thinking to that which generated the " Escort " and " Squire " ; there is now a much simplified tail gate, the entire rear panel hinging upward to beyond the horizontal ; it is counterbalanced by torsion bars and stays up by itself. The side windows no longer slide, but the rearmost pair can, optionally, hinge open about the leading edge. The spare wheel is stowed below the floor of the rear compartment. On the estate car the 7·5 : 1 and 8·9 : 1 compression ratios are optional ; the final drive is 4·44, as on the commercial vehicle.

An important feature of the Salon was the appearance of two more engines with petrol injection. The Maserati 3500 G.T. is now available with Lucas fuel injection, a developed form of the system used in competition on Jaguar cars ; the fuel distribution is controlled not from the throttles, which in the Maserati are butterflies, but from the pressure in the balance pipe connecting the six ram pipes. A convertible Peugeot " 404 " (heading illustration) will next year be available with injection into the ports ; the advantage in power alone is conspicuous, the output increasing from 72 h.p. to 85 h.p. at 5500 r.p.m. and the maximum brake mean effective pressure from 144 lb per square inch at 2250 r.p.m. to 155 lb per square inch at 2800 r.p.m. The indirect injection engine has a best specific consumption of 0·4 lb per h.p.m., but



(Left) The new Ford estate car shares the name and the mechanical components of the " Anglia " saloon. (Right) The fuel injection engine of the Peugeot 404 : from the shallow intake silencer the air passes down to the throttle and then up into the manifold, which is connected by straight pipes to the ports. As can be seen, the pump is linked mechanically to the throttle

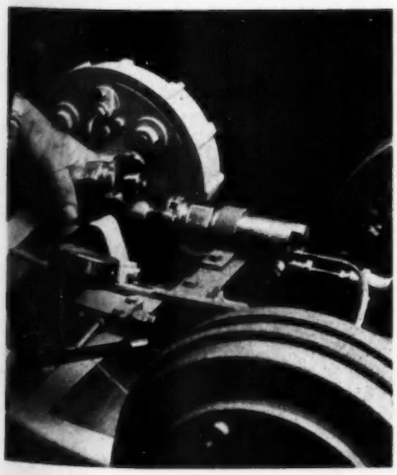
it is not stated where in the torque and speed range this occurs nor how the carburetted engine compares. The pump in this case is mechanically controlled, and is a product of Kugelfischer Georg Schafer and Co., Münich ; the Kugelfischer pump differs from the familiar jerk pumps in having at the head of each element a large inlet valve. The pump is lubricated by the engine oil system.

Among the single and multiple disc brakes on the stand of Messier (Rue Fenelon, 58, Montrouge) was one in which the disc was driven at the outside, thus minimising the area sterilised by the caliper. Whereas most such brakes have the

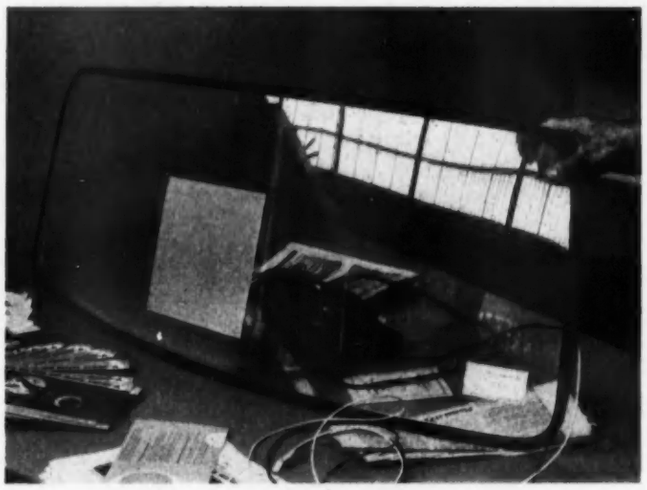
The disc in this Messier floating-caliper brake is supported by a light steel drum, swaged over the edge of the disc

disc floating on dogs, in this case the caliper is free to float and the disc is secured to a light steel drum. It is clear that this construction is most economic for cars with detachable rims, but when it is considered that discs driven from the hub are often almost completely shielded on one side to protect them from road dirt, it appears that the drum is not an extravagant support for the disc ; it serves both to isolate the bearings from heat and, to some extent, as a radiator.

For the operation of hydraulic brakes on trailers towed by vehicles which themselves have hydraulic brakes, Satmo (Aurec-sur-Loire) have evolved a coupling which intrinsically isolates the towing vehicle's hydraulic system from faults in the trailer or connection ; the only additional risk



Mechanical coupling for operating trailer hydraulic brakes from a tractor hydraulic brake system



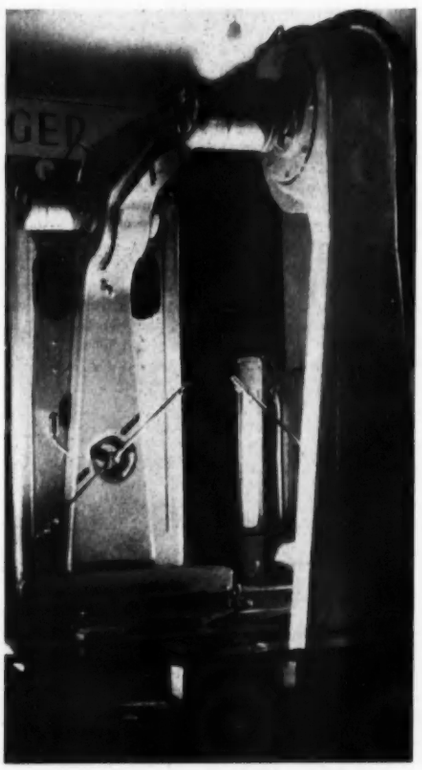
A " Triplex " windscreen heated by an invisible grid of fine wires

of loss of integrity is that due to the presence of one more slave cylinder and a pipe to serve it. This slave cylinder actuates a plain plunger which is not free to pass out of the cylinder. When the trailer brakes are coupled up, this plunger abuts the plunger of a relay cylinder which supplies the slave cylinder of the trailer brakes. When the trailer is disconnected, a blank connector is placed in position to hold the plunger on the towing vehicle forward and therefore keep the brake pedal travel at its normal value. It is obvious that failure of the flexible hose or of any part of the trailer system will mean only the plunger running to the end of its travel, and also that leakage from the trailer is not made good from any reservoir. When it is necessary to bleed the system or to replenish the fluid on the trailer, the two halves of the coupling are joined together by a short

The two halves of the " Devos " constant velocity universal joint are identical

length of pipe entering the back of the sealing screws of the bleed orifices.

The " Devos " universal joint (licence Faure) appeared on the stand of Ersa (Rue des Faurelles, 177, Courbevoie). This joint appears simple compared to other constant velocity universal joints in that the torque is transmitted by only two steel balls, while a third at the centre of the joint maintains the coincidence of the shafts. The construction of the joint will be perceived from the accompanying illustration ; the two halves of the joint are identical. The joint is dismantled by removing a pin which locates the ball shaft in the centre ball and extracting the ball shaft ; the joint can then be pivoted so that one pair of ball tracks are parallel and that ball can be pushed out. These joints are capable of

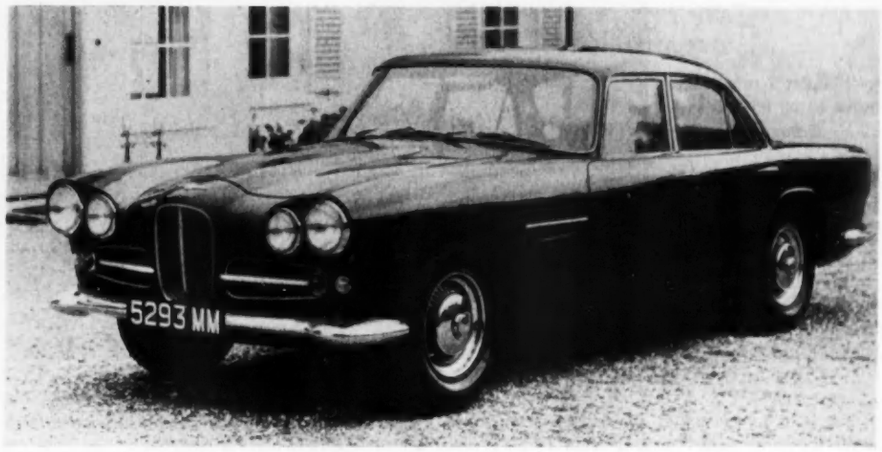


Through the archway of this plant for washing both body and chassis can be seen the illuminated column of a tyre inflating rig

running outside a torque tube if provided with a rubber cover, and the one illustrated is in fact directly interchangeable with the standard Hooke's joint on the 2 c.v. Citroën.

An interesting technique for de-misting and de-frosting windows was displayed by Société Industrielle Triplex under the name " Therglas." Whereas in the United Kingdom glass is usually heated by a conductive gold film which imposes a distinct optical loss, " Therglas " is heated by very fine wires embedded in the interlayer of a laminated assembly. Where perfect transparency is not mandatory, as, for instance, in the rear windows of road vehicles, the wires run straight from edge to edge and are, with an effort, perceptible ; for driver's windshields an even

CONTINENTAL AFFAIRS *(Continued)*



The new Lagonda "Rapide" has de Dion drive

finer wire is laid sinusoidally, and in this case the wire is hard to see with a magnifying glass. These windows appear to have significant advantages over those with gold films, at least where a laminated construction is desirable ; they can be designed to use any voltage from 6 to 1500V and give any heat rate from 0·1W per square inch to 70W per square inch—and the cost is such that they can be considered, at least as an an option, for private cars.

It is not, however, possible to vary the amplitude of the sine wave described by the wire through a single grid, and hence this process does not compete with "Sierracote" for application to areas not defined by parallelograms.

The servicing equipment of Emanuel (via Tommaso Grossi, 18, Turin) included a plant for washing small vehicles both above and below ; it is claimed that the underside can be cleaned in three minutes and that the body can be washed

This steel tow-rope is endowed with resilience by a rubber shock-absorber

and dried off within fifteen minutes. Our illustration shows that the plant uses rotating sprays, which for cleaning the body can be supplied with detergent, and in the top of the arch are two fans which blow through a slit in the underside of the cross-member to blow surplus water off the body. It will be obvious that the chassis-cleaning facility will have a great value in countries where snow and ice are countered with salt.

Emanuel also offers a combined air and water dispenser with a particularly direct and easily read presentation, visible, in the case of the free-standing model illustrated, through 360 deg. The display is composed of two opal Plexiglass tubes, of which the outer carries a scale of pressure and the inner is forced down into the fluid within the outer by the air line pressure ; thus as the pressure increases the level of the fluid in the space between the tubes rises. The inner tube contains not only the air pressure sensing cylinder and piston but also a fluorescent tube to illuminate the display. The special fluid, "Filoplex," does not freeze above −40 deg. and calls for no temperature correction, i.e. its bulk coefficient of expansion with temperature is equal to the linear coefficient of plexiglass. The accuracy claimed is ±50 gm per square centimetre, i.e. less than 1 per cent f.s.d. The standard carries a water hose with a valved nozzle as well as air lines.

Another Italian product on show was a Gev tow-rope of steel, cushioned to give it the resilience, if not flexibility, of nylon. The cable, which is sheathed in nylon to protect it from abrasion and corrosion and to render it less hard on the hands, is threaded through a rubber shock absorber, so that to straighten the cable the rubber must be deformed. As our illustration shows, the tow-rope is provided at each end with a loop and safety hook and at the middle with a flag to render it obtrusive.

CERN Report, 1960

THE Annual Report of the European Organisation for Nuclear Research (CERN) for the year 1960 has now been published.* Expenditure during the year was just in excess of 66,000,000 Swiss francs, of which about one-half was incurred in connection with the operation of the organisation's two large particle accelerators, the proton synchrotron (PS) and the synchro-cyclotron (SC). For this year, a rise to nearly 70,000,000 Swiss francs is envisaged. Staff, including visiting scientists, numbered 1052 at the end of the year. In February, the proton synchrotron was officially inaugurated.

Following the death in April in an aircraft accident of the director-general of CERN, Professor C. J. Bakker, Mr. J. B. Adams was appointed acting director-general and later director-general until August, 1961. He has now been succeeded by Professor V. F. Weisskopf who will remain in office until the end of July, 1963.

The Theoretical Study Division (ten staff members, average number of scientists including visitors, forty) is concerned mainly with five groups of problems : elementary particles (in particular strange particles, their strong interactions and decay modes, weak interactions) ; quantum field theory ; quantum electrodynamics ; pion physics ; statistical treatment of particle production at high energies. In addition, the Division has the task of advising the experimental groups of the CERN laboratory, a matter which will increase in importance as the work of the PS develops.

* Sixth Annual Report of the European Organisation for Nuclear Research. Geneva : Obtainable from the Department of Scientific and Industrial Research, Charles House, 5-11, Regent Street, London, S.W.1.

The 25/28 GeV PS which came into operation on November 24, 1959, was made available to research teams. Performance was gradually stepped up and a number of installations were completed. The number of protons accelerated during each cycle has been increased from 2×10^{10} protons/pulse at the beginning of 1960, to $2{\cdot}5\times10^{11}$ protons/pulse towards the middle of the year. Systematic studies of the behaviour of the machine have been carried out with a view to improving performance.

Secondary particle beams are obtained by allowing the proton beam to impinge on one of two targets. The outgoing beams are focused by quadrupole lenses and analysed by bending magnets. Two kinds of secondary bursts are normally produced, a long, structure-free one (tens of milliseconds up to 40ms) and a short intense burst (hundreds of microseconds) for bubble chamber work. For the high-intensity bursts an RF knock-out drives the beam rapidly on to a thick target. Low-intensity bursts are produced by a finger target whipped across the beams. Over 2300 hours of operation were achieved.

Among the main items of equipment may be mentioned the CERN 500 litre (1m) heavy liquid bubble chamber which was first used in December, 1960. It consists of a polished stainless steel cylindrical body surrounded by a system of water pipes and closed at one end by a vertical glass window 25cm thick and 1·15m in diameter which is protected by a 1500 litre safety tank, with a thick end plate supporting the cameras. The expansion system, mounted at the opposite end, consists of a rubber membrane, a perforated plate supported by a magnet pole, two co-axial pneumatic valves, and five toroidal reservoirs. Thick glass tubes inside the chamber contain the flash lamps. A servo-actuator maintains in the safety tank a pressure slightly higher than the static pressure in the chamber. The chamber is mounted inside an 82-ton, 4·5MW magnet expected to create a field of 2·4Wb per square metre.

Work has continued on the experimental programme for this chamber and the 1m heavy liquid bubble chamber from the Ecole Polytechnique, Paris. With the latter, over 90,000 photographs have been taken.

The possibility of detecting high-energy neutrons from the PS by means of their interactions in heavy liquid bubble chambers has been investigated. An experimental arrangement has been found which least disrupts the rest of the programme and requires about 5000 tons of shielding. A magnetic horn is being studied which will focus π-mesons over a large momentum range, and increase the neutron flux at the bubble chambers by one order of magnitude.

During the year all bending magnets and the majority of the quadrupole lenses for the PS beam transport system have been delivered and a repeat order for the East experimental area has been placed. Design and production of components for three electrostatic beam separators has proceeded.

During 1960, the scientific activity of the SC Division was largely characterised by the beginning of research work with the PS. Work with the SC included experimental determinations of the Panofsky ratio, polarised ions, pion physics, and fission and spallation studies.

Under "Scientific and Technical Services," the Report mentions the commissioning of three digitising projectors (IEP 2, 3 and 4) as part of the development programme of instruments for the evaluation of photographs (IEP). There will altogether be seven such machines. In order to evaluate a photograph, the operator uses a joystick to bring the instrument to the initial point of the track which is then followed automatically. The co-ordinates of successive prints are recorded on punched paper tape. An I.B.M. 709 computer has been installed and a large part of the computation work previously done on the "Mercury" computer is being transferred to it.

Road Safety Research

FORTY THOUSAND to 50,000 people are killed every year in road accidents in Western Europe. For every person killed, ten are injured seriously, forty slightly. These figures are still on the increase. In the U.S.A., another 40,000 are killed. The economic burden imposed by these casualties has been estimated to reach between 1 and 1½ per cent of the gross national product.

Scientific studies of road accidents must therefore be considered to be of primary importance. With a view to expediting the obtaining of results and minimising cost, the O.E.E.C. organised a meeting of road safety research directors from thirteen member and associate countries to discuss future action. The findings of meeting are contained in an O.E.E.C. report which has just been published.*

The purpose of the meeting was, in the main, to explore the present state of road safety research with the special aim of examining the need for internation co-operation, to suggest which current or future researches could be facilitated by international co-operation, to consider how the present means of disseminating research results could be improved, to encourage international co-operation in road safety research, and to see what arrangements, organisations or methods of working, were needed and how they could be established.

The need for effective road safety measures (says the report) is now recognised in most countries but the scientific study of the problems has progressed to very different extents in different countries. As might be expected, the United States, the country in which motor transport has developed furthest, carries out a considerable volume of research in a great variety of institutions. In the United Kingdom, most of the work is done by one body, the Road Research Laboratory, while some medical aspects are being dealt with by the Medical Research Council, and there is a beginning of research interest at the universities. The automobile and lighting industries are concerned with certain aspects of road safety research.

In Europe different countries have given their main attention to different aspects of the subject. Sweden, for instance, has pursued the question of safety belts for cars further than any other European country ; Austria appears to have given prominence to psychological studies ; and the Netherlands are eminent in the field of street lighting.

Co-operation in road safety research is important because there is a wide variety of problems and the solution of even one of them may demand expert knowledge in many fields. The institutions engaged in the work are diverse in character ; government departments, universities, hospitals, &c., and the journals in which reports are published. Partly as a result of this diversity there is often a lack of co-operation or even of mutual understanding between the different organisations engaged in road safety research. On the other hand, Denmark, Finland, Norway and Sweden, have already begun to organise co-operation among themselves.

On an international level a number of organisations are concerned with road problems in general and with road safety in particular. However, there is at present no international body whose sole or even main concern is road safety research, especially if by this is meant international co-operation at the technical level.

Dissemination of Information.—In all countries there are journals, sometimes several, which publish road safety research results. They are, however, mostly specialist journals so that the research literature of road safety is very widely scattered and it is quite easy for workers in one speciality to be ignorant of or overlook the journals in which other aspects of the subject are being treated. Moreover a good deal of research in the U.S.A. is reported in monograph form and therefore does not get indexed into the literature. Journals specialising in road safety might help to concentrate the field of publication, but in several countries there would not be enough material available to support such a journal.

Only two abstract journals are published in this field : *Highway Research Abstracts* (U.S.A.) and *Road Abstracts* (U.K.).

An information centre for road safety research exists in the U.S.A., the National Safety Council Research Correlation Service. Brussels has the International Documentation Centre for the Technical Inspection of Motor Vehicles and the Nordic countries are considering setting up a documentation service on transport questions with centres in each country.

Such arrangements cannot be considered satisfactory. There is some desire for a journal or journals devoted to road safety research. The greatest need, however, seems to be an adequate abstract service. Details of a system of information dissemination should receive further study.

To avoid wasteful duplication of work, it is also necessary to know what research is in progress or being planned elsewhere. In several countries it is felt that a greater co-ordination of research is as important as improvement in the means for disseminating the result.

Subjects for Co-operative Research.—The following subjects were judged suitable for international co-operation :

1. Driver behaviour under different priority rules and its correlation with accidents.
2. Other aspects of road user behaviour, such as, where pedestrians cross the road, the care they take in doing so and the relationship of these to accidents.
3. The effect of speed limits on accidents, particularly in towns.
4. The effect on accidents of different designs of lighting columns, signs, kerbs and other items of street furniture.
5. The standard of aiming headlight beams and its relation to sharpness of cut-off.
6. The effects of alcohol and drugs and measures against them.
7. Crash injury and especially the efficiency of protective devices like seat belts and crash helmets.
8. Certain aspects of the slipperiness of road surfaces.

International Research.—The meeting recommended the establishment of an independent international body to foster road safety research. Such a body would be of value not only to countries just entering this field but also to those where research is already well developed. It would help to raise the efficiency of research by improving the communication of information and fostering co-operation.

One of the first essentials for efficient international co-operation is the existence within each country of a national co-ordinating body to act as a link between that country and the international body. As a first step towards promoting international co-operation in the road safety field a directory of research institutes should be compiled giving information on equipment, personnel and current programmes and bibliography.

Crash Injury Research

Safety Belts.—During 1958 and 1959, 500,000 car safety belts were manufactured in Sweden, all complying with prescribed standard requirements. The annual production of safety belts rose in 1960 to 400,000 and even then, the production rate was below demand.

In 1959 about 25 per cent and in 1960 about 50 per cent of cars had one or more seat belts. Very few were fitted with belts on the rear seat also and belts were very much more common in new cars than in old.

In 1958, full-scale collision tests were carried out with European cars using different types of belts to retain anthropometric dummies weighing about 60 kg. As a result it was possible to lay down official requirements with which safety belts should comply. It was demonstrated that for safety belts to be effective they should pass a dynamic test with a dummy in a special vehicle which could be decelerated from 40km.p.h. to 0 by about 100 *g* during which the dummy should move forward no more than 30cm as the belt stretches. The deceleration of the dummy is of the order of 50 *g*.

Earlier belts, although effective, also had a number of practical disadvantages. A belt which is simple to use and which is becoming popular is the so-called "three-point belt," consisting of one hip strap and one chest strap. It is anchored to the doorpost and two points in the floor on both sides of the occupant's seat and consequently has no tendency to move upwards and the dummy remains in a parallel position.

For detailed observations to be made during full scale tests, special recording apparatus had to be elaborated. Normal accelerometers and tensiometers of a strain gauge type were subject to discrepancies due to vibration from different parts of the car. Furthermore, in high-speed photography the scale factor is important and the radial distortion and stretching of the film when it is passed through the camera at a considerable speed may give rise to error also.

Errors can be reduced to approximately 0·5mm by a method which consists essentially of taking stereographs with a camera with known distortion, using a stroboscopic lamp for timing.

According to Swedish opinion, among all the safety measures which have been taken to improve the safety of vehicles none have produced more positive results than the use of car safety belts.

Work on this problem has also been undertaken from 1946 onwards by the United States Aero-Medical Laboratory. The task was to render less dangerous by the use of harness and safety belts the decelerations met with in aircraft crashes. Research was later extended to automobile crashes because almost as many Air Force men were being killed in the latter as in the former. Experiments have been carried out on humans, hogs, chimpanzees and anthromorphic dummies. Living subjects must be used because a dummy cannot reveal what injuries a man would suffer ; dummies were used only for measuring forces and accelerations.

It has been demonstrated that a forward-facing man wearing a full safety harness can stand a maximum deceleration of 40 to 50 *g*, this high value being maintained for about 0·1 second in a total duration of about 0·25 second, and suffer no injury. This, however, is not the limit. For the fully restrained subject facing forward about 60 *g* applied at a rate of 5000 *g* per second and for a duration of 0·1 to 0·5 second can be sustained without injury. Above this there is a wide margin, to a deceleration somewhere above 200 *g* and a rate of application of 5000 *g* per second, before the injury is fatal. A backward facing person supported by an adequate seat is even safer and can stand about 90 *g* without injury. People have survived accidental decelerations of nearly 200 *g* when the force was distributed widely over the body.

The possibility of crash protection by the restraining devices tested may be summed up by saying that a deceleration of 40 *g* can be protected against completely with adequate harness. In terms of the automobile this means that in a head-on crash at 60 m.p.h. in which the vehicle may be expected to collapse by about 3ft it should be possible for the driver to walk away unharmed. The restraining force on the man would be about 8000 lb. The large majority of crashes are less severe than that.

Injury in Relation to Vehicle Design.—The Automotive Crash Injury Research Group at Cornell, with a full-time staff of forty-five working with the police and medical authorities of seventeen States has amassed the fullest available records on 45,000 injury and property accidents and 85,000 medical cases. The information is analysed to find the relationships between the injuries and certain features of the design of the vehicle or of the accident situation.

One of the facts discovered in the early days of this analysis was the importance of preventing the door from opening. In 56 per cent or vehicles involved in injury accidents the door

* "Research into Road Safety." Report on the First International Meeting on Research into Road Safety, organised by O.E.E.C. at the Road Research Laboratory, Langley (United Kingdom), July, 1960. Paris : Organisation for European Economic Co-operation, 2, rue André-Pascal, Paris (16e). See also THE ENGINEER, July 22, 1960, page 158.

CONTINENTAL AFFAIRS *(Continued)*

opened and 25 per cent of the occupants of these vehicles were ejected. By comparison of similar accidents it was found that an ejected front seat occupant was twice as likely to suffer moderate to fatal injury, and five times as likely to be killed, as one who remained inside the vehicle.

As a result of this discovery a better type of lock was fitted in 1956 and seat belts were offered as optional equipment. When cars with seat belts began to appear in the accident records, the effect of the belt was evaluated from pairs of accidents, the two accidents of a pair being similar in ten respects but differing in the use or non-use of a belt. In several thousand accidents eighty-one such matched pairs were found. They showed that with the belt in use the chance of sustaining a moderate to fatal injury was only 40 per cent of the normal rate.

An analysis of the components of the vehicle involved in injuries showed that the steering wheel, instrument panel, or windshield were involved in 56 per cent of injuries.

As regards injuries to pedestrians the problem in the U.S.A. is rather different from that in Europe ; of 37,000 deaths only about 7000 are pedestrians, and a large proportion of these are over sixty-five or under ten years of age. The best line of attack here may be educational : training pedestrians to cross at the proper places.

Several lines of crash injury research are being pursued at the Road Research Laboratory of the United Kingdom. Their purpose is to collect factual information on the nature and causes of injuries in relation to vehicle design in order that modifications of design may be suggested. The work is carried out by on-the-spot investigation of accidents, collection and analysis of data on injuries, experiments on controlled impacts and the study of protective devices.

Stimulated by the work at Cornell, the Laboratory began the detailed study of individual accidents about six years ago. When notified by the police of an accident within about 8 miles of the laboratory, a team of three or four research workers goes to gather information about the vehicle, the manoeuvres, the damage and the injuries. They look for tyre and skid marks and photograph the vehicles and the surroundings. For obtaining a plan view of the scene use is made of a suspended camera which can be operated at heights up to 45ft. From a study of about 550 accidents, a number of facts stand out.

Seat failure is common. Injuries due to impact with the steering wheel show that rigid columns and wheels cause much more serious injuries than those that can bend. Loss of control is found to be much more common than had been expected. Injuries are caused when rear passengers are flung against the backs of the front seats. The injuries caused by rear impacts through the jerking back of the head can be very long lasting. Face and head injuries are frequently due to impact with the windscreen and the behaviour of the two types of windscreen glass in common use (toughened and laminated) has been studied. These studies of accidents show in what directions the manufacturer can improve the safety of his vehicle. But satisfactory design can only be based on quantitative data and the Laboratory has been compelled to carry out controlled crash experiments. This work is still in its early stages.

Crash Helmets.—The crash helmet, at the time the United Kingdom Road Research Laboratory began work on it, had a hard shell and a harness of webbing material which kept the shell at a small distance from the head. This afforded good protection against a blow on the crown, but was not so effective for blows at front, back or sides. In actual motor-cycle accidents, helmets are damaged chiefly at front and back and on the sides. Alternative means of absorbing the energy of the blow were then sought and this led to research into the properties of padding materials.

It is still uncertain what deceleration the head can stand without damage ; and it has been concluded that a peak value of about 700 *g* might be just tolerable. A value of 500 *g* was therefore adopted, which corresponds to a peak force of 5000 lb on a 10 lb head. This figure may appear high, but is not unduly so, for it is known that windscreens which crack at about 2000 lb have been broken without damage to the head. An instrument has been constructed to record the force-time curve of the blow transmitted through a layer of padding material from a 10 lb falling mass. A development of this instrument is now used in the routine testing of three out of every 200 helmets sold in the United Kingdom. To carry out the test, the helmet is placed on a wooden head form, and given a blow both front and back delivered by a 10 lb weight falling from 7ft. The helmet passes the test if each blow results in a transmitted force of less than 5000 lb. Of a set of three helmets chosen for test, one is tested hot, one cold, and one wet, the conditions being specified in a British Standard. A helmet of the old type with a hard shell and webbing alone can not stand more than 40 ft lb before reaching the limit of 5000 lb peak force ; with 0·25in of cork in addition it can sustain 60 ft lb and with 0·5in of cork it can sustain 80 ft lb. Although there has been no legislation, about 60 per cent of riders now wear crash helmets.

Alcohol and Driving.—With regard to the effects of small doses of alcohol upon skilled driving performance, there are three main views : that behaviour deteriorates as soon as there is detectable alcohol in the blood ; that there is no deterioration up to a concentration of about 50 to 80 milligrammes of alcohol per 100 millilitres of blood (50 to 80 milligrams per cent); that small amounts of alcohol actually do you good and that deterioration only sets in at the 50 to 80 milligrams per cent level.

A number of subjects were given the task of " driving " along an endless repeating " road " in an apparatus simulating a motor-car, having been given alcohol in doses of either 0·0, 0·2, 0·35, 0·5 and 0·65 g per kilo of body weight, the largest of these corresponding to a blood alcohol maximum of about 80 milligrams per cent, equivalent to about 3 pints of beer. This is well below the value of 150 milligrams per cent, accepted in some states in the U.S.A. as the point beyond which no one may safely drive.

The average score for the whole group of subjects showed that tracking error (divergence from a path parallel to the kerb) increased steadily with blood alcohol, that is, there was no threshold below which average performance remained unaltered or improved. Movement of the steering wheel also increased. There was no significant change in the speed at which the course was covered. Differences between individual performances (some of which went against these average trends) were principally correlated with that extraversion-introversion. Thus it seems extraverts are less responsive to the fact that alcohol is affecting them ; they maintain their speed and simply make more errors. The introverts appear to attempt to compensate for the effect of alcohol and to demonstrate their efficiency. For one group the criterion seems to be slow cautious driving, for the other, rapid driving.

Although the evidence is not conclusive the results suggest that some of the individual differences in response can be explained in terms of personality structure. As to the point at which alcohol in the blood begins to take effect, it seems as though even very small concentrations have an effect, but that the nature of the effect tends to vary with personality.

Julich Nuclear Research Centre

On September 28, the Nuclear Research Centre at Jülich was officially inaugurated as the central research and training establishment of the Land North Rhine-Westphalia. It was in 1957 that the decision was made to set up the new centre on a site of—at present—1·8 square kilometres in the 4 square kilometre area of the state-owned forest of Stetternich near Jülich. Much use has been made in the construction of standardised building design. The layout, broadly speaking, follows the principle of increasing radioactivity in the various installations along an axis from the north-west to the south-east. The Institute of Biology (Department of Botany), Plasma Physics, and Reactor Design have been completed, as well as a temporary building for the Institute of Radiochemistry, the Radiation Safety Centre, the Administrative Centre, reception buildings, a social centre, and the purification plant.

The research reactor FRJ 1 (" Merlin ") has been completed and will be charged during the next four weeks. Nearing completion are a second research reactor, the FRJ 2 (" Dido "), which will probably enter service in 1962, the Institute for Reactor Components, the main engineering workshop, telephone exchange, and central heating station. A medical institute is under construction. Seven further institutes, a building for " hot " compartments, and the central library and lecture theatre are still in the planning stage.

The " Merlin " reactor was supplied for the most part by A.E.I.-John Thompson Nuclear Energy Company, Ltd., while " Dido " is basically a German copy of the design at Harwell by Head Wrightson Processes, Ltd.

One of the first tasks of the Institute for Reactor Design will be experimental work in connection with the B.B.C./Krupp High Temperature Experimental Reactor (A.V.R.) which is being constructed on the site of the Centre. Of the DM. 200 million which have been authorised for the Centre, about three-quarters have been spent so far, of which DM.13,000,000 were the cost of the " Merlin " project, DM32,500,000 that of the " Dido " reactor, and some DM. 20,000,000 the cost up to the present of the various institutes. The first stage is to be completed in 1964.

WGL Annual Meeting

The annual meeting of the Wissenschaftliche Gesellschaft für Luftfahrt (WGL) will take place from October 10 to 13 in Freiburg im Breisgau. Papers will be given dealing with space flight, aerodynamics and navigation, gas dynamics, power units, fuels, materials and components. Besides German scientists, there will be participants from the U.S.A., Great Britain and France. A full social and ladies' programme is being arranged. Those interested are asked to communicate with the Secretariat, Wissenschaftliche Gesellschaft für Luftfahrt e.V., Cologne, Martinstrasse 40/42.

Application of Oxy-Acetylene

The " Commission Permanente Internationale de l'Acetylene, de la Soudure Autogène, et des Industries qui s'y rattachent," 32, Boulevard de la Chapelle, Paris (18e), has published the regulations governing the Fourth International Competition for a paper on the applications of the oxy-acetylene flame. The competition is open from October 1, 1961 until March 31, 1962. Full details are available from the Permanent Commission on application, or from the British Acetylene Association, Carbide House, 55, Gordon Square, London, W.C.1 (Tel.: Museum 8784).

Sackingen Power Station

Work has commenced on the construction of the Rhine power station of Sackingen. This represents the last stage in the hydro-electric exploitation of the river between Schaffhausen and Basle. The head will be about 18ft and the station will be equipped with five turbo-generator sets of producing a mean annual output of about 400 million kWh which will be shared equally between Switzerland and Germany. The total cost of the project is estimated at approximately 190 million Swiss francs.

THE AMERICAN SCENE

By Our American Editor

Computer Programming System for Civil Engineering Problems

The development of a new " language " which will greatly simplify communication between civil engineers and computers was recently announced by Professor C. L. Miller, director of the Civil Engineering Systems Laboratory at the Massachusetts Institute of Technology, Cambridge, Massachusetts. The new computer programming system is called " COGO " and makes it possible for the engineer to give instructions to digital computing machines using the technical language of the civil engineering profession—the same words one engineer would use in describing a problem to another engineer. The computer understands such words as " locate," " inverse," " intersect," " area," " ramp," " alignment," and similar engineering terms.

THE " COGO " computer programming system for civil engineering problems was developed during the past year by Professor C. L. Miller, director of the Civil Engineering Systems Laboratory at the Massachusetts Institute of Technology, Cambridge, Massachusetts. The name " COGO " is derived from CO-ordinate GeOmetry, which is the mathematical basis for the system. " COGO " can be applied to the computation problems involved in control surveys, highway design, right-of-way surveys, flyover design, bridge geometry, land surveying, construction layout, and all similar problems related to points and lines in space. The concepts and techniques illustrated by the " COGO " system can be extended to other problem areas such as structures, hydraulics, photogrammetry, &c. The system has the following characteristics.

1. The instructions or commands to the computer, which the engineer uses to express the solution of a problem, are at approximately the same technical language level as instructions which one engineer would use in describing his solution to another engineer. Hence, " COGO " appears to the user to be a problem-oriented computer language for civil engineers.

2. A new and unique programme is written by the engineer for each set of data. No two problems need ever be exactly alike. The engineer has complete freedom to use his own imagination, experience, judgment, and creative ability in solving each problem as it arises and can communicate with the machine in his own terms.

3. " COGO " programmes are used only once and then discarded since they can be written in minutes and involve no investment.

4. Each command to the computer and the data to be used in executing the command are entered into the computer at the same time. The following are four examples of " COGO " statements (English command plus required numerical data) :

```
STORE            46
LOCATE/AZIMUTH   19  46  172.17   35  14  26
LOCATE/ANGLE     97  19  46  100.00   90 0 0
INVERSE/BEARING  46  97
```

5. Very extensive problems can be solved in a continuous run on the computer because the programmes can be indefinitely long. An entire flyover design can be thought of as a single problem requiring only one trip to the computer.

Geometric Problems in Civil Engineering

During the past five years, civil engineering organisations have devoted considerable attention to programming geometric problems on digital computers. Programmes for computing traverses, curves, alignment, right-of-way, ramps, and bridge geometrics have been among the principal production activities of such organisations. The standard approach to programming geometric problems works fairly well when a particular problem is well defined and recurs very often in the same form. Within a given organisation, it is possible to standardise a problem, such as traverse computations, so that the same fixed programme may be used repeatedly. However, there are numerous geometric problems which have the following characteristics. (1) Each problem is somewhat different in terms of the nature of the known data and the sequence which must be followed in making the computations. (2) The problems are often inter-related, the answers or output from one problem being required for data or input to a subsequent problem.

Both of these characteristics are difficult to cope with in using fixed programmes on a computer. The second characteristic is a result of the relatively limited memory of the small and medium computers in common use by civil engineering organisations. Attempts to cope with such problems with fixed programmes result in a large number of small programmes evident in most programme libraries. However, the engineer commonly finds it distasteful to force the method of solution to a rigid data form which must be filled out in a precise manner, compounded by the need to keep returning to the machines for separate individual runs.

The " COGO " System

The " COGO " System is an attempt to help solve the problems mentioned above. The design of the system was based on a rather extensive analysis of the practical problems involved in using computers on civil engineering projects. A large number of standard library programmes were carefully reviewed. It was found that most geometric problems could be reduced to two fundamental operations : (1) Compute the location (co-ordinates) of points given various sets of information such as distance and direction from a known point, intersection of two lines, offset from a known point to a curve, &c. (2) Compute the length and direction of lines between known points. It was also evident that such operations and most related problems could be efficiently solved mathematically in terms of co-ordinate geometry.

Fixed programmes can be thought of as a fixed sequence of the above two fundamental operations with fixed input and output specifications, over which the engineer has little or no control. " COGO " may be thought of as a programming system which gives the engineer complete control over the sequence of such operations and the form of input and output.

Use of the System

The heart of the system is the simple concept of a co-ordinate table. Each point involved in a problem is given an identification number. As each point is " located," the co-ordinates of the point are stored in the co-ordinate table and are, henceforth, available for subsequent computations by simply referring to the point number. The use of the co-ordinate table and the system may be illustrated by a simple example. Consider the problem shown by Fig. 1 with the following known data :

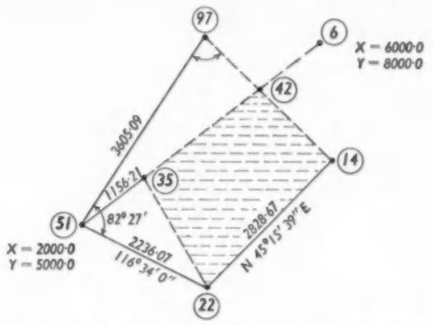


Fig. 1—Representative civil engineering problem for the " COGO " method

(*a*) The co-ordinates of point 51 and 6 ;
(*b*) The length and azimuth of the line 51-22 ;
(*c*) The length and bearing of the line 22-14 ;
(*d*) The length of line 51-97 and the counterclockwise angle at 51 from 22 to 97 ;
(*e*) The length of the line 51-35 ;
and the following desired answers :
(*a*) The co-ordinates of all points ;
(*b*) The length and bearing of the line 14-97 ;
(*c*) The angle at 97 from 14 to 51 ;
(*d*) The area of the parcel bounded by points 35, 42, 14, 22, and 35 and the length and azimuth of the sides of the parcel.

One possible programme which an engineer might write to solve this problem is as follows :

```
STORE            51      2000.00      5000.0
LOCATE/AZIMUTH   22  51  2236.07  116  34  00
LOCATE/BEARING   14  22  2828.67    1  45  15  39
LOCATE/ANGLE     97  51  22  3605.09   −82  27  00
INVERSE/BEARING  97  14
ANGLE            14  97  51
STORE            6       6000.0       8000.00
POINTS/INTERSECT 42  51   6  14  97
LOCATE/LINE      35  51  42  1156.21
AREA/AZIMUTHS    35  42  14  22  35
```

The above statements are " COGO " shorthand for the following longhand statements :

(*a*) Store the co-ordinates (X=2000, Y=5000) of point 51 ;

(*b*) Locate point 22 by going a distance of 2236·07ft from point 51 at an azimuth of 116 deg. 34 min. 00 sec. Output the co-ordinates of point 22 and store them ;

(*c*) Locate point 14 by going a distance of 2828·67ft from point 22 at a bearing of N 45 15 39 E (Quadrant=1). Output the co-ordinates of point 14 and store them ;

(*d*) Locate point 97 by going a distance of 3605·09ft from point 51 at a direction defined by turning a counterclockwise (minus) angle of 82 deg. 27 min. 00 sec. at point 51 from the line to point 22. Output the co-ordinates of point 97 and also store them ;

(*e*) Inverse between points 14 and 97 and output the distance and bearing of the line from 14 to 97 ;

(*f*) Compute and output the clockwise angle at point 97 from 14 to 51 ;

(*g*) Store the co-ordinates (X=6000, Y=8000) of point 6 ;

(*h*) Locate point 42 as being the intersection of the line between points 51 and 6 with the line between points 14 and 97. Output the co-ordinates of point 42 and also store them.

Also, inverse between 51 and 42 and between 14 and 42 and output the distances and bearings.

THE AMERICAN SCENE *(continued)*

```
*         THIS IS A PRINT OF COMPUTER  OUTPUT ILLUSTRATING COGO
*                  ABC STATE HIGHWAY DEPARTMENT
*         COMPUTATION OF RIGHT-OF-WAY TAKINGS AND CONSTRUCTION LAYOUT
*         CONTRACT SECTION 49J-256-1192                PROJECT 496-2
*         JONES J. JONES, ENGINEER                     AUGUST 11, 1961
*                              ******
CLEAR
STORE                  51  2000.0  5000.0  MAINLINE STATION 1776+14.09
LOCATE/AZIMUTH         22  51   2236.07  116  34  00
   22     3999.9740      3999.9436
LOCATE/BEARING         14  22   2828.67  1  45  15  39
   14     6009.2303       5990.9893
LOCATE/ANGLE           97  51   22   3605.09  -82  27  0
   97     4022.0215       7984.6445
*         COMPUTE BEARING FROM 14 TO 97 FOR FIELD CHECK
INVERSE/BEARING        97  14
   97        14          2814.8984          4       44       54     25.984800
*         COMPUTE ANGLE AT 97 FOR PLANS
ANGLE                  14  97  51
   14        97          51                 79       1     25.910400
STORE                  6  6000.   8000.00  CENTERLINE STA. 2051+15.88
CALL        INTERSECT PROGRAMS PLUG DECK
POINTS/INTERSECT       42  51  6  14  97
   42     4859.3998      7144.5499
   42       51           3574.2494          1       53       7     48.367200
   42       14           1628.7449          4       44       54    25.974000
CALL        LOCATE PROGRAMS PLUG DECK
LOCATE/LINE            35  51  42  1156.21
   35     2924.9679      5693.7260
*         COMPUTE AREA AND AZIMUTH DESCRIPTION OF THE TAKINGS
*         OF PARCEL NO. 4681, F. CASTRO, OWNER
AREA/AZIMUTHS          35  42  14  22  35
   42       35           2418.0397          53       7     48.367200
   14       42           1628.7449          135      5     34.044000
   22       14           2828.6687          225      15    38.952000
-4721657.6
-1201.3186
DUMP
    6     6000.0000      8000.0000
   14     6009.2303      5990.9893
   22     3999.9740      3999.9436
   35     2924.9679      5693.7260
   42     4859.3998      7144.5499
   51     2000.0000      5000.0000
   97     4022.0215      7984.6445
*         THATS ALL FOR NOW AMIGOS
PAUSE
*                              ****
*                              ****
*
```

Fig. 2—Sample print of output from the " COGO " system applied to solving the problem of Fig. 1

(*i*) Locate point 35 as being on the line between 51 and 42 at a distance of 1156·21ft from point 51 ;

(*j*) Compute the area enclosed by points 35, 42, 14, 22 and 35. Output the area in square feet and acres and also output a table of distances and azimuths for each side of the enclosed area.

The " COGO " statements are written on any convenient sheet of paper by the engineer. Each line is then punched on a card just as it appears, leaving at least one blank space between each piece of data, or typed directly into the computer.

Some additional operational features of the system are as follows :

(1) Any card or line which starts with an asterisk (*) is treated as a comments or remarks card and is reproduced in the output at the time it is read by the computer. This allows the engineer to be as " wordy " as he cares to be in fully identifying himself, the project, the problem, the data, and the output.

(2) All statements are duplicated in the output along with the answers. This means that the programme, the data, and the results appear as one continuous listing, eliminating the problem of relating output to input.

(3) If the command name is left blank on a statement, and only the data is given, the machine uses the previous name. This can be thought of as an automatic ditto. For example, an open traverse programme takes the form of a single command, like " LOCATE/BEARING," followed by a series of distance and bearings.

(4) If the engineer attempts to use a command name not in the machine's " vocabulary," the condition is detected and an error message is typed.

(5) A series of control commands are available to facilitate use. Some of these are listed here.

(*a*) CLEAR—causes the co-ordinate table to be cleared out to avoid any risk of using the last user's co-ordinates.

(*b*) DUMP—causes all defined points in the co-ordinate table to be punched out in a form which can be read back in at a later date.

(*c*) PAUSE—causes the machine to cease automatic operation to give an opportunity for manual intervention, such as switching from card input to typewriter input, advancing the paper in the typewriter, making a choice between a " two " solution problem, &c.

(*d*) CALL—causes the machine to read in a new set of " COGO " routines.

Fig. 2 is a print of the " COGO " output for the previous problem illustrating these features.

Computer Application

An understanding of how " COGO " works internally may be explained by discussing one specific system—the so-called Puerto Rico " COGO " system for a 20 K card IBM 1620 machine. An overall system flow chart is shown in Fig. 3. The key routine is the " COGO " Control Routine which reads the statements, interprets the command name, determines what action to take, processes " CALL " statements, and sends control to the proper set of machine language instructions.

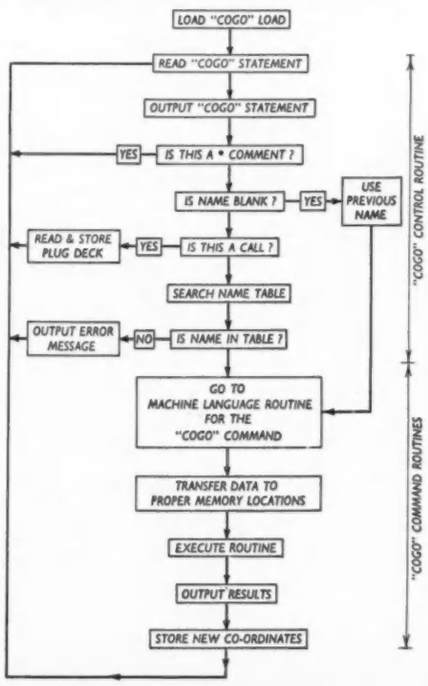


Fig. 3—Overall flow chart of the " COGO " system using plug decks on a 20K card IBM 1620 computer

Each command may be thought of as a conventional machine language programme ranging from a few to hundreds of machine language instructions. The Control Routine function is to send control to the proper internal programme, such as a programme for intersecting two lines or adjusting a traverse. All such programmes for all " COGO " commands cannot be stored in the internal core memory at the same time. To solve this problem for a small memory, a " CALL " system was developed. When the Control Routine detects a " CALL " card, it reads and stores the following 100 cards into a section of memory. The " plug " decks of 100 cards each contain a group of related programmes. The plug decks are inserted directly in the deck of statements at places where they will be needed by the statements which follow. This permits continuous runs of indefinite length without any operator intervention.

The " LOAD " deck contains all of the floating point and fixed point arithmetic sub-routines, the input/output data conversion sub-routines, the control routine, and seven basic " COGO " routines always in memory. It also sets up the co-ordinate table, name table, data area for the basic routines, and the " LOCATE " plug deck. Each plug deck contains from two to eleven routines plus associated data area and name table. Hence, there is a common area of memory which is not affected by " CALL " statements plus a variable area which changes each time a plug deck is read in; 24 seconds are required to read in and store a new plug deck. The important memory areas are shown in Fig. 4.

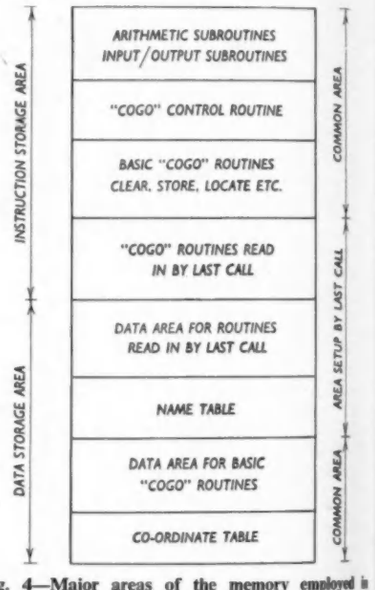


Fig. 4—Major areas of the memory employed in conjunction with the " COGO " system

The individual " COGO " programmes for a given command name were initially written in the " FORTRAN " language and then translated into machine language using the " FORTRAN " processor. By making the routines use each other and not writing them as individual programmes, it has been possible to pack a relatively large number of powerful routines into a small memory. The principal advantage of having the source programme in " FORTRAN " language is the ease of modifying and expanding the system. The ability to expand the system easily is very important. Operational experience will always reveal the desirability of adding additional new commands to the vocabulary of the system and of modifying old commands. This ability is also essential to the feasibility of developing " custom-built " " COGO " systems for particular organisations and particular configurations.

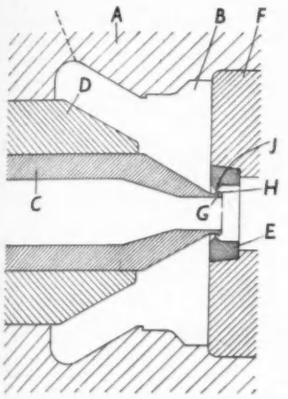
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

EXTRUSION

876,350. February 17, 1959.—IMPROVEMENTS IN EXTRUSION, Felten and Guilleaume Carlswerk Aktiengesellschaft, Köln-Mülheim, Germany.

When in extruding tubes or cable sheathings, the extruding operation is interrupted, a so-called bamboo ring is formed over the width of which the extruded product has a reduced wall thickness. The invention aims at preventing, in a simple manner, the formation of these bamboo rings by making effective use of the relative axial displacement undergone by the mandrel and die and their holders whenever there is a variation in pressure. This is done by bringing about an alteration in the wall thickness of the extruded product. The accompanying drawing depicts an embodiment, by way of example, of a mandrel and die assembly for carrying the method into effect. *A* designates the press head, *B* the pressing chamber, *C* the hollow mandrel secured in the mandrel-holder *D*, *E* is the die mounted in the die-holder *F*. In accordance with the invention the mandrel, has at its tip *G* an external annular reinforcement *H* whilst the die has an annular constriction *J*, the reinforcement on the mandrel tip being located



No. 876,350

downstream from the constriction in the die, with respect to the direction of extrusion. When the necessary extrusion pressure is applied to the material, the mandrel and the die are forced away from one another axially, whereby the annular gap between *H* and *J* is reduced to the required wall thickness of the extruded product. When the extrusion pressure ceases, the mandrel and the die move resiliently towards one another ; as a result of this movement, the annular gap between *H* and *J* increases. The extruded material passing through the gap is therefore thickened and not constricted at the point corresponding to stoppage of the extrusion pressure. The die may be immovably supported so that a variation in the extruding force brings about an axial movement of the mandrel only and not of the die. In this case, axial movement of the mandrel will take place as the extruding force varies, and bring about a variation of the gap by which the tube is formed. Conversely, the mandrel may be supported so that axial movement of the die will take place and bring about a variation in the gap.—*August* 30, 1961

ELECTRIC TRACTION

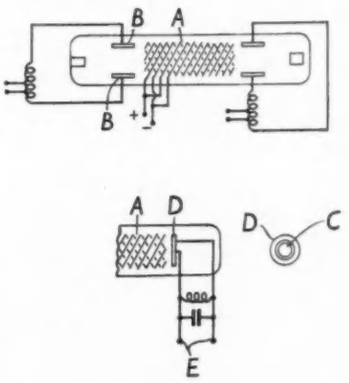
875,959. February 25, 1957.—REGENERATIVE BRAKING, Associated Electrical Industries, Ltd., 33, Grosvenor Place, London, S.W.1. (*Inventor : Gordon Collins*).

The regenerative operation of traction equipments is liable to cause embarrassment in the event of the supply conductors becoming non-receptive to regenerated current. Where traction equipments have automatic shunt or separate excitation control, non-receptivity of the supply conductors will result in a very rapid rise of motor armature voltage due to the endeavour of the control arrangements to increase the excitation so as to maintain the regenerated current in conditions such that the necessary armature current cannot be caused to flow at the normal traction motor voltages. Tests have demonstrated that the voltage rise can be so rapid, for example as much as 100,000 volts per second, that dangerous voltages can be reached before conventional over-voltage relays could respond. According to the present invention, electronic voltage sensitive means are provided responsive to the motor armature voltage during regenerative operation in combination with a high speed contactor which is used to connect a load across the motor armature circuit and so prevent the motor voltage rising above a desired value. The voltage sensitive means preferably comprises a thyratron. In the operation of equipments according to the invention, since a state of equilibrium is quickly re-established, the loading resistor can be rated for a short time period, for example of the order of one second or less. The specification shows the invention applied to a two-motor d.c. equipment for a motor coach, with separately-excited fields for regeneration which are normally opposed by the motor series fields. Regulation of the separately-excited fields might be by means of a sectionalised resistance controlled by a pilot motor-driven camshaft. Should the power supply line become non-receptive, as, for example at a break in its continuity, the opposing effect of the series fields is immediately lost and the generated voltage will rise rapidly. The loading resistor is connected across the motor armature circuit in series with normally-open contacts of a high-speed contactor. This includes a bucking coil which is normally de-energised, but when energised results in rapid operation of the contactor by neutralising the flux produced by a normally-energised holding winding. The bucking coil is connected in series with the anode and cathode of a thyratron across the motor armature circuit. A cold cathode valve is preferred for economy in space and cost, and is more robust. Bias is arranged so that the loading contactor contacts are normally open, but when the armature voltage rises to the predetermined value, say 750 volts, the thyratron fires and energises the bucking coil of the loading contactor.—*August* 23, 1961.

ELECTRONICS

876,836. August 19, 1959.—ELECTRON BEAM PARAMETRIC AMPLIFYING AND FREQUENCY CONVERTING TUBES, English Electric Valve Company, Ltd., Queens House, Kingsway, London, W.C.2. (*Inventor : Frank Neville Hosband Robinson.*)

The object of the present invention is to provide improved electron beam amplifying or frequency converting tubes adapted to utilise the parametric principle, and such that the necessity is avoided for applying an alternating frequency to a pump system. The corresponding effect is obtained by an electrode arrangement which is substituted for the pump electrode system and is fed merely by static, i.e. direct current, potentials. Referring to the upper drawing it will be seen that the difference between the tube of this figure and known tubes consists essentially in the fact that the pump system of the known tube is omitted and in its place is employed a twisted electrode system *A*. This electrode system consists of



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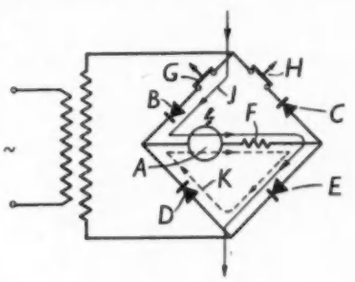
four helical wires interposed with one another like the four threads of a four-start screw, the whole twisted electrode system being co-axial with respect to the axis. The electron beam follows a spiro-helical path of increasing diameter within the length of the coupler *B*, the twisted electrode system being used to produce a similar effect to that produced by the conventional pump of a known tube, that is a modification of the spiro-helical path of the beam entering the system, such that on leaving it the beam traces a momentarily annular area. Direct-current potentials, as conventionally illustrated, applied to alternate wires of the twisted electrode system, produce a quadrupole field which, although static, appears to an electron within it to have a rotating component, causing the same effect as the rotating field of a conventional pump system of a known parametric tube, but without the necessity of applying alternating p.d.'s to the pump system. The lower drawings show a frequency converter tube in which there is no output coupling system and the collector electrode, instead of being the normal single element electrode, is a two-element electrode system consisting of a central disc *C* surrounded by an annulus *D*. These two electrodes are connected to the ends of an output tuned circuit across which are the output terminals *E*.—*September* 6, 1961.

ELECTRICAL ENGINEERING

876,787. June 2, 1958.—PROTECTING RECTIFIERS AGAINST OVER-CURRENTS, Siemens-Schuckertwerke Aktiengesellschaft, Berlin and Erlangen, Germany.

According to the invention there is provided a circuit arrangement for supplying a direct-current load through rectifiers from an alternating-current supply system and for protecting the rectifiers against over-currents. A particularly simple arrangement is obtained with a bridge or Graetz circuit, since in this case the circuit-breaking devices may be provided only on one side of the bridge, while the second side of the bridge may serve as a balancing circuit. In the example illustrated, a direct-current motor *A* is supplied through rectifier elements *B* to *E* from the secondary side of a single-phase transformer. Choke *F* serves to smooth the load current. Circuit breaking devices *G* and *H* are included in the branches which contain the rectifiers *B* and *C*. These devices are controlled in dependence upon the current through the load with the aid of rapidly-responding control elements (not shown), such for example as saturable chokes. When a short-circuit occurs in the load, the



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opening of one of the devices *G* and *H* is first brought about with the aid of these control elements. It is here assumed that the short-circuit occurs while the load current is flowing through the rectifiers *B* and *E*, that is to say, through the current path indicated by a thin unbroken line *J*. By means of the control, the circuit-breaking device *H* is first opened in such a case, this taking place without difficulty because the device is momentarily relieved of current. Owing to the opening of *H*, no current can flow in the path through the two rectifiers *C* and *D* during the immediately following half-cycle and current flow is maintained only by virtue of the energy stored in the inductances of the circuit. The current through the rectifier element *B* will, therefore, die down in a very short time, so that the circuit-breaking device *G* can also be opened without current. The control means for the devices *G* and *H* are so arranged that the device *G* is opened either during the half-cycle which immediately follows the half-cycle in which the device *H* is opened or in a shortly following half-cycle in which the device *G* is relieved of current. The supply current, which under normal conditions can be regarded as constant if the smoothing is sufficient, rises to a higher value at the instant of the short-circuit, but ceases at the next passage of the current through zero or shortly thereafter. In the balancing circuit, the current flow continues for a short time until the stored magnetic energy has been dissipated. The path of this balancing current *K* is represented by a thin broken line and its direction is indicated by the arrow.—*September* 6, 1961.

Catalogues and Brochures

LANCASHIRE DYNAMO AND CRYPTO, Ltd., Acton Lane, Willesden, London, N.W.10.—Folder giving dimensions, outputs and prices of the "Crypto-D" range of totally-enclosed fan-cooled cage rotor electric motors with class "E" insulation.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., Electronic Apparatus Division, Carholme Road, Lincoln.—Leaflet No. 4481-82 giving characteristics of 100A. and 80A. controlled silicon rectifiers for motor control, high-speed static switching servo systems, high-power inverters and regulated A.C. power supplies.

THE ENGLISH ELECTRIC COMPANY, Ltd., English Electric House, Strand, London, W.C.2.—Illustrated publication, TD/152, "'English Electric' Traction," showing diesel and diesel-electric locomotives and motor coaches supplied or equipped by the company for railways in many parts of the world. Industrial locomotives for surface and underground haulage at collieries are included.

MULLARD, Ltd., Components Division, Mullard House, Torrington Place, London, W.C.1.—Booklet on "Magnadur" permanent magnets, giving characteristics of the various grades, with suitable applications for each. Factors governing the length and cross-sectional area of any permanent magnet are discussed, and some general rules are given for the guidance of designers using "Magnadur."

RADIOVISOR PARENT, Ltd., Stanhope Works, High Path, London, S.W.19.—Folder illustrating applications of photo-electric control panels for industrial monitoring, timing and counting purposes. In all the installations shown, a number of controls depending on photo-electric cells at various locations are centralised in master panels which may be standard units or built to specification.

HOT DIP GALVANIZERS ASSOCIATION, 34, Berkeley Square, London, W.1.—Booklet entitled "Hot Galvanizing—The Process and the Product." This is the second of a series of technical booklets being issued by the Association. It describes the hot galvanizing process, and has notes on the formation of alloy layers, coating appearance (including information on the production of spangle), corrosion resistance, fabrication of galvanized products, and methods of finishing. Some typical uses are listed.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Imperial Chemical House, Millbank, London, S.W.1.—Brochure entitled "A Changing Pattern." Illustrated in colour, the brochure describes the work of the Metals Division of I.C.I. A short historical introduction, detailing the organisations which came together to form the division, is followed by descriptions of its products, of which brass and copper are the oldest and, in bulk, the most important. In recent years some of the new metals have been added to the division's production, and titanium, zirconium, beryllium, hafnium, niobium and vanadium are dealt with in turn. The brochure also describes some of the other activities of the division and its subsidiaries, such as the production of ammunition and zip fasteners, of carburetters and fuel equipment, of electrical insulators, and the fabrication of non-ferrous metals. Printing is another of the division's activities, and the present brochure is, appropriately, printed by a division subsidiary, the Kynoch Press.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Oct. 16.—BOURNEMOUTH AND DISTRICT BRANCH: Grand Hotel, Firvale Road, Bournemouth, "Earth-Fault-Loop Impedance Tests and Testers," R. B. Kerley, 8 p.m. ★ BRISTOL AND WEST OF ENGLAND BRANCH: Royal York Hotel, Bath, "Rectifiers," J. C. McGill, 8 p.m. ★ MID-ESSEX BRANCH: White Hart Hotel, Tindal Street, Chelmsford, "Safety in the Utilisation of Electricity," S. J. Emerson, 7.45 p.m.

Tues., Oct. 17.—BRADFORD AND DISTRICT BRANCH: Institute of Technology, Bradford, "Colour Television," G. N. Patchett, 7.30 p.m. ★ NATIONAL EVENT: Institution of Electrical Engineers, Savoy Place, London, W.C.2, Presidential Address, "Impressions of Electrical and Educational Developments in Uganda, Kenya and Rhodesia," Sir Willis Jackson, 6.15 p.m. ★ OXFORD AND DISTRICTS BRANCH: Board Room, Employment Exchange, St. Aldates, Oxford, "Earth Loop Testing and Earth Resistance Measuring," J. Gomersall, 7.30 p.m. ★ WEST KENT BRANCH: Royal Star Hotel, Maidstone, "Stage Lighting Equipment," F. E. Brown, 7.30 p.m.

Wed., Oct. 18.—PORTSMOUTH AND DISTRICT BRANCH: Royal Air Force Association Club, Cosham, Portsmouth, "Industrial Application of Photo-electric Cells," E. G. Sills, 7.30 p.m. ★ WOLVERHAMPTON AND DISTRICT BRANCH: Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "General Application of Refrigeration in Industry," P. Nevitt, 7.45 p.m.

Thurs., Oct. 19.—NORTH LONDON BRANCH: Visit to Thorn House, Atlas Lighting, Ltd., 6.15 p.m. ★ NEWCASTLE UPON TYNE AND DISTRICT BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, 10, "Office Lighting," R. A. Hall, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Oct. 18.—RADAR GROUP: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, Symposium on "Digital Differential Analysers," 6 p.m. ★ MERSEYSIDE SECTION: The Walker Art Gallery, Liverpool, "Colour Television," G. N. Patchett, 7.30 p.m.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

To-day, Oct. 13.—Harrogate, Hydrogen in Steel Conference, Opening lecture by Professor A. R. Troiano who will deal with the role of hydrogen in the mechanical behaviour of metals.

CEMENT AND CONCRETE ASSOCIATION

Tues., Oct. 17.—Technical College, School of Building, Arragon Road, East Ham, London, E.6, "Concrete Handling on Building Sites," A. W. Rickard, 7.15 p.m.

Wed., Oct. 18.—College of Technology, Department of Building and Civil Engineering, Salmon Pastures, Warren Street, Sheffield, "Fire Resistance of Concrete Structures," M. R. Hollington, 7.15 p.m. ★ College of Building, Hardman Street, Manchester, 3, "Recent Developments in Concrete," A. J. Harris, 7.15 p.m. ★ North Oxfordshire College and School of Art, Bath Road, Banbury, "Prestressed Concrete," H. Kaylor, 7.15 p.m.

CHEMICAL SOCIETY

Thurs., Oct. 19.—LONDON BRANCH: Burlington House, London, W.1, "Stereochemical Control in Oxidative Cyclisation," F. M. Dean; "A New Group of Antibiotics," I. O. Sutherland and W. D. Ollis, and "Rotenoids and their Relatives," L. Crombie, 7.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., Oct. 18.—MIDLAND REGION: Birmingham Chamber of Commerce, 75, Harborne Road, Edgbaston, Birmingham, Discussion on "The Case for the Unattended Boilerhouse," opened by Hugh Hill and F. D. Brand, 10.30 a.m.

Thurs., Oct. 19.—Northern Exhibition of Fuel and Power for Industry, Queens Hall, Sovereign Street, Leeds, 1961 Conference on "Grit and Dust from Small Boiler Plants" and "N.I.F.E.S. Seventh Progress Survey," 10.15 a.m.

DIESEL ENGINEERS AND USERS' ASSOCIATION

Thurs., Oct. 19.—Institute of Marine Engineers, 76, Mark Lane, London, E.C.3, Annual General Meeting, and Symposium on "Reclaiming Worn or Damaged Parts of Diesel Engines," 2.15 p.m.

ILLUMINATING ENGINEERING SOCIETY

Tues., Oct. 17.—NORTH LANCASHIRE GROUP: Demonstration Theatre, North Western Electricity Board, 19, Friargate, Preston, Presidential Address, W. T. Souter, 6.30 p.m.

Mon., Oct. 23.—BIRMINGHAM CENTRE: Chamber of Commerce, 75, Harborne Road, Edgbaston, Birmingham, 15, "Floodlighting in Colour," J. W. Bessant, 6.30 p.m. ★ LEEDS CENTRE: British Lighting Council, 24, Aire Street, Leeds, 1, "Office Lighting," R. G. Hopkinson, 6.15 p.m. ★ LEICESTER CENTRE: Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, "The New I.E.S. Code," W. E. Harper, 6.15 p.m.

Tues., Oct. 24.—LIVERPOOL CENTRE: Industrial Development Centre, Paradise Street, Liverpool, "The New I.E.S. Code," H. E. Bellchambers, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., Oct. 17.—EAST ANGLIAN SECTION: Lecture Theatre, Ipswich Civic College, Rope Walk, Ipswich, "Art Bronze Founding," A. L. Parrott, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Oct. 17.—SOUTHERN JOINT BRANCH: Royal Hotel, Cumberland Place, Southampton, Joint meeting with the Royal Institution of Naval Architects, "Metallurgy in Marine Engineering," J. E. Garside, 7.30 p.m.

Wed., Oct. 18.—SOUTH WALES SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "Lloyd's Register of Shipping Requirements in the Testing of Welders," F. B. Bowring, 6 p.m.

Thurs., Oct. 19.—WEST MIDLANDS SECTION: Queen's Hotel, Birmingham, "Fashioned in Steel," R. C. Benson, 7 p.m.

INSTITUTE OF METALS

Mon. to Wed., Oct. 16 to 18.—Assembly Hall, The Royal Commonwealth Society, Craven Street, London, W.C.2, Conference on "The Metallurgy of Beryllium."

Thurs., Oct. 19.—SHEFFIELD LOCAL SECTION: Applied Science Building, The University, St. George's Square, Sheffield, Film Evening, 7.30 p.m.

INSTITUTE OF NAVIGATION

Wed., Oct. 18.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Off the Beaten Track," 2.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, Oct. 13.—S. WALES CENTRE: S. Wales Institute of Engineers, Park Place, Cardiff, "Wear and Tear (Part II)," J. E. Johnson, 7.15 p.m.

Tues., Oct. 17.—NORTH EASTERN CENTRE: Three Tuns Hotel, Durham City, "Automatic Transmission Control Systems for Heavy Commercial Vehicles," R. B. Robinson, 7 p.m.

Wed., Oct. 18.—NORTH WESTERN CENTRE: Merton Hotel, Merton Street, Liverpool, 20, "Road Safety," W. Todd, 7.30 p.m. ★ SOUTH EASTERN CENTRE: Royal Star Hotel, Maidstone, "Oil Additives," E. P. Wright, 7.30 p.m. ★ SOUTH WESTERN GROUP: City Fire Brigade Headquarters, Exeter, Technical Films, 7.30 p.m.

Thurs., Oct. 19.—LONDON AND METROPOLITAN AREA: Royal Society of Arts, John Adam Street, London, W.C.2, Sixteenth Annual General Meeting, and Films, 6.30 p.m. ★ YORKSHIRE CENTRE: Royal Victoria Hotel, Sheffield, Film, "Truck Rodeo," and Discussion 7.30 p.m.

Mon., Oct. 23.—SCOTTISH CENTRE: North British Hotel, Edinburgh, "Materials Handling—Its Equipment and Maintenance," D. MacDonald Walker, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 17.—Great George Street, Westminster, London, S.W.1, "The Narrows Bridge—Perth, W. Australia," J. W. Baxter, E. M. Birkett, and E. W. H. Gifford, 5.30 p.m.

Thurs., Oct. 19.—Great George Street, Westminster, London, S.W.1, Discussion on "Sewage Disposal at Coastal Towns," introduced by W. P. Haldane, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Oct. 13.—N. SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, Centre Chairman's Address, E. G. Cullwick, 6 p.m.

Mon., Oct. 16.—LONDON GRADUATE AND STUDENT SECTION: Savoy Place, London, W.C.2, Chairman's Address, "Experimental Techniques Developed for Determining the Performance of Fuel Elements in Nuclear Reactors," C. F. Price, 6.45 p.m.

Tues., Oct. 17.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "The Place of Digital Computers in the Teaching of Electrical Engineers," opened by P. D. Aylett, 6 p.m. ★ EAST MIDLAND CENTRE: The University, Nottingham, "Safety in the Utilisation of Electricity," S. J. Emerson, 6.30 p.m. ★ NORTH MIDLAND UTILISATION GROUP: Leeds and County Conservative Club, South Parade, Leeds, 1, Chairman's Address, F. Clarke, 6.30 p.m. ★ NORTH-WESTERN MEASUREMENT AND CONTROL GROUP: Engineer's Club, Albert Square, Manchester, Chairman's Address, "Some Protection and Automatic Features of the British Grid," E. C. Smith, 6.15 p.m.

Wed., Oct. 18.—SUPPLY SECTION: Savoy Place, London, W.C.2, Chairman's Address, "Research and Transmission," J. S. Forrest, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Visit to Fuller Electric, Ltd., 2 p.m. ★ EAST MIDLAND CENTRE: Angel Hotel, Peterborough, "The Kariba Dam Project—Electrical Installations," C. J. Dickinson, 7.30 p.m. ★ NORTH-WESTERN ELECTRONICS AND COMMUNICATIONS GROUP: Engineer's Club, Albert Square, Manchester, Chairman's Address, "Developments in Broadcasting," W. R. Fletcher, 6.15 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Water-Turbine-Driven Induction Generators," C. L. C. Allan, 6 p.m. ★ SOUTHERN CENTRE: Technical College, Brighton, "Communication over a Power Network with Special Reference to Power Line Carrier," D. P. Howson, and I. R. Smith, 6.30 p.m. ★ SOUTHERN ELECTRONICS AND CONTROL GROUP: C.E.G.B. Offices, High Street, Portsmouth, "Bandwidth Compression of Speech," K. Holywell, 6 p.m.

Thurs., Oct. 19.—NORTH MIDLAND CENTRE: Lecture Theatre, Y.E.B. Offices, Ferensway, Hull, "Transport and Electric Traction," G. Streets, 6.30 p.m. ★ WESTERN CENTRE: North Gloucestershire Technical College, Cheltenham, "Radiocommunication in the Power Industry," E. H. Cox and R. E. Martin, 6 p.m.

Sat., Oct. 21.—LONDON GRADUATE AND STUDENT SECTION: Visit to the Medical Research Council, 10 a.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 24.—39, Elmbank Crescent, Glasgow, "The Atom ... the Future," W. R. Wootton, 6.30 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS

Wed., Oct. 18.—YORKSHIRE BRANCH: Broadway Hall, Hor... forth, Near Leeds, "Engineer-Architect Collaboration," G. Grenfell Baines, 7.30 p.m.

Fri., Oct. 20.—MANCHESTER AND DISTRICT BRANCH: Engineers' Club, Albert Square, Manchester, "Air Conditioning ... Operating Theatres," R. Blowers, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Thurs., Oct. 19.—MIDLAND BRANCH: Magistrates Court, Wo... wick, Paper by I. A. Cram, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Mon., Oct. 23.—EAST MIDLANDS BRANCH: Room 104, College of Technology and Commerce, Leicester, Repetition of ... Clayton Lecture, "Machine Tool Research, Design and Utilisation," D. G. Galloway, 7.15 p.m.

Tues., Oct. 24.—EASTERN BRANCH: Dijon Restaurant, Buffet ... Discussion on "Theory and Practice of Management," 7.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., Oct. 19.—GENERAL MEETING: Geological Society, Burlington House, Piccadilly, London, W.1, "Mining Practice on the Kolar Gold Field, India," J. T. M. Taylor, 5 p.m.

INSTITUTION OF PLANT ENGINEERS

Wed., Oct. 18.—LONDON BRANCH: Visit to the Omnibus Repair Depot, L.T.E., Aldenham, Near Edgware, 9.15 a.m. ★ KENT BRANCH: South Eastern Gas Board Lecture Hall, 95, High Street, Rochester, "The Economics of Back Pressure Generation," 7 p.m.

Thurs., Oct. 19.—BLACKBURN BRANCH: Castle Hotel, Blackburn, "The Maintenance Problems in a Nuclear Power Station," J. R. Treharne, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Oct. 13.—IPSWICH AND COLCHESTER SECTION: Electric House, Ipswich, Lecture by R. V. Taylor, 7.30 p.m.

Mon., Oct. 16.—SHEFFIELD GRADUATE SECTION: Newton Chamber and Co., Ltd., Thorncliffe, Near Sheffield, Works visit and "A Modern Mechanised Foundry," 7 p.m.

Tues., Oct. 17.—EAST AND WEST RIDINGS REGION: Lecture Theatre, Engineering Tower, Huddersfield Technical College, Halifax, "Machine Tool Development in the U.S.S.R.," N. Stubbs, 7.30 p.m.

Wed., Oct. 18.—MIDLANDS REGION: Midland Hotel, Birmingham, "Recent Developments in Mechanical Transfer for Machines and Assembly," H. Bezier, 7 p.m. ★ WOLVERHAMPTON GRADUATE SECTION: Wolverhampton and Staffs. College of Technology, Wulfruna Street, Wolverhampton, "Sand Moulding and its Recent Developments," A. D. Lewis, 7.15 p.m. ★ SOUTH EASTERN REGION: Old Ship Hotel, Brighton, "Modern Trends in Machine Tool Design," E. R. Cash 7 p.m.

Thurs., Oct. 19.—WOLVERHAMPTON GRADUATE SECTION: Works visit to Ferro Enamels, Ltd., Ounsdale, Wombourn, Staffs., 7 p.m.

Mon., Oct. 23.—NORTH MIDLANDS REGION: Louis Room, St. James's Restaurant, St. James's Street, Derby, "Speed Machining as an Aid to Production," S. V. Divers, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Oct. 13.—WESTERN COUNTIES BRANCH: Queen's Building, University Walk, Bristol, Chairman's Address, Clifford E. Saunders, 6 p.m.

Mon., Oct. 16.—NORTHERN COUNTIES BRANCH: Neville Hall, Newcastle upon Tyne, Chairman's Address, L. Dotson, 6.30 p.m.

Tues., Oct. 17.—LANCASHIRE AND CHESHIRE BRANCH: College of Science and Technology, Manchester, Chairman's Address, J. B. Story, 7 p.m.

Wed., Oct. 18.—YORKSHIRE BRANCH: Metropole Hotel, Leeds, Chairman's Address, T. E. S. White, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 13.—ORDINARY MEETING: Pepys House, 36, Rochester Row, London, S.W.1, "The Technician, Education and Industry," J. Heywood, 7 p.m.

Fri., Oct. 20.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Recent Trends in Telecommunications," R. A. Hill, 7 p.m.

LIVERPOOL JOINT CHEMISTRY COMMITTEE

Wed., Oct. 18.—Lecture Theatre, Grosvenor Museum, Chester, "The Use of Oil in the Steel Industry," R. Mayorcas, 7.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., Oct. 18.—Royal Institute of British Architects, 66, Portland Place, London, W.1, "Tropical Architecture: The Development of Reinforced Concrete in West Africa," E. Maxwell Fry, 6 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Wed., Oct. 18.—QUANTITY SURVEYORS GENERAL MEETING: 12, Great George Street, Westminster, London, S.W.1, "Computers—Their Use in Working Up," D. A. Bunt, 6 p.m.

ROYAL METEOROLOGICAL SOCIETY

Wed., Oct. 18.—49, Cromwell Road, London, S.W.7, "Some Aircraft Observations of Fluxes of Solar Radiation in the Atmosphere," W. T. Roach; "The Absorption of Solar Radiation by Water Vapour and Carbon Dioxide in a Cloudless Atmosphere," W. T. Roach, and "An Empirical Method for Estimating Long-Wave Radiation Exchanges in the British Isles," J. L. Monteith, 5 p.m.

SOCIETE DE CHIMIE INDUSTRIELLE

Thurs. and Fri., Oct. 19 *and* 20.—Maison de la Chimie, Paris, Symposium on "Corrosion in the Nuclear Energy Industry."

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 18.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, "Volatile Corrosion Inhibitors": "Principles," E. Ll. Evans, and "Practical Applications," K. H. Gibbons, 6 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Thurs., Oct. 19.—39, Elmbank Crescent, Glasgow, Presidential Address, R. Hunter, 6.45 p.m.